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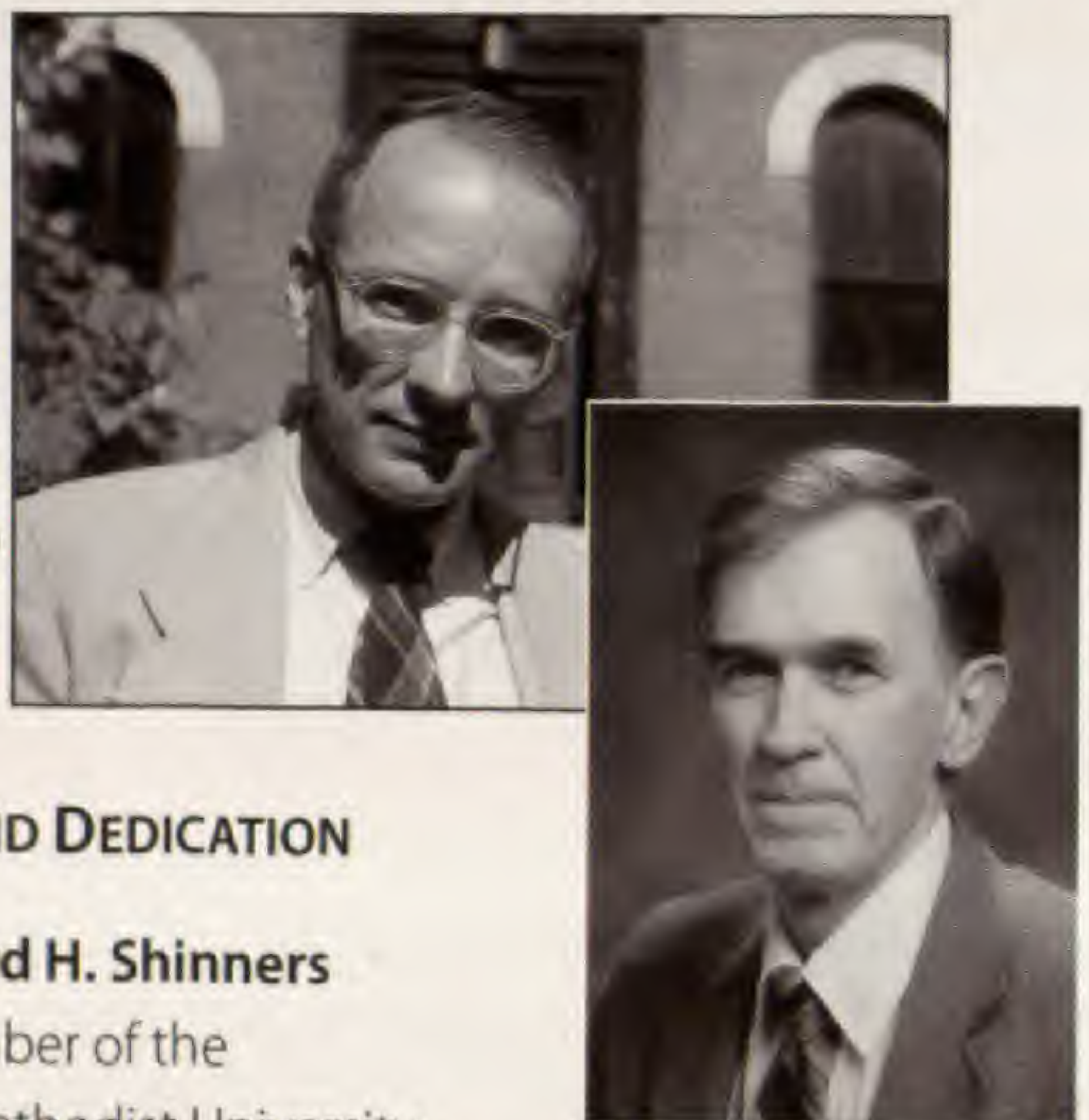

HISTORY AND DEDICATION

1962—Lloyd H. Shinners (left), a member of the Southern Methodist University (SMU) faculty and a prolific researcher and writer, published the first issues of *Sida, Contributions to Botany* (now *J. Bot. Res. Inst. Texas*)

1971—William F. Mahler (right), professor of botany at SMU and director emeritus of BRIT, inherited editorship and copyright.

1993—BRIT becomes publisher/copyright holder.

2007—First issue of *J. Bot. Res. Inst. Texas.*

MISSION AND GOALS

The BRIT Press seeks innovation and excellence in preparation, manufacture, and distribution of botanical research and scientific discoveries for the twenty-first century.

The BRIT Press—bringing out the best in botanical science for plant conservation and education.

DIRECTION AND COVERAGE

The BRIT Press considers original research papers concerned with classical and modern systematic botany, sensu lato, for publication in *J. Bot. Res. Inst. Texas.* All submissions are peer-reviewed. Guidelines for submissions are available from the BRIT Press website, http://www.britpress.org.

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COVER ILLUSTRATION

Electronically tinted botanical illustration of *Liatris aestivalis* originally used on BRIT's anniversary poster 2001. Summer gayfeather flowers mid Jul–Aug(–Sep) and is endemic to Oklahoma and Texas. Sida 19:768. 2001. Botanical illustration by Linny Heagy ©2001.

BRIT PRESS

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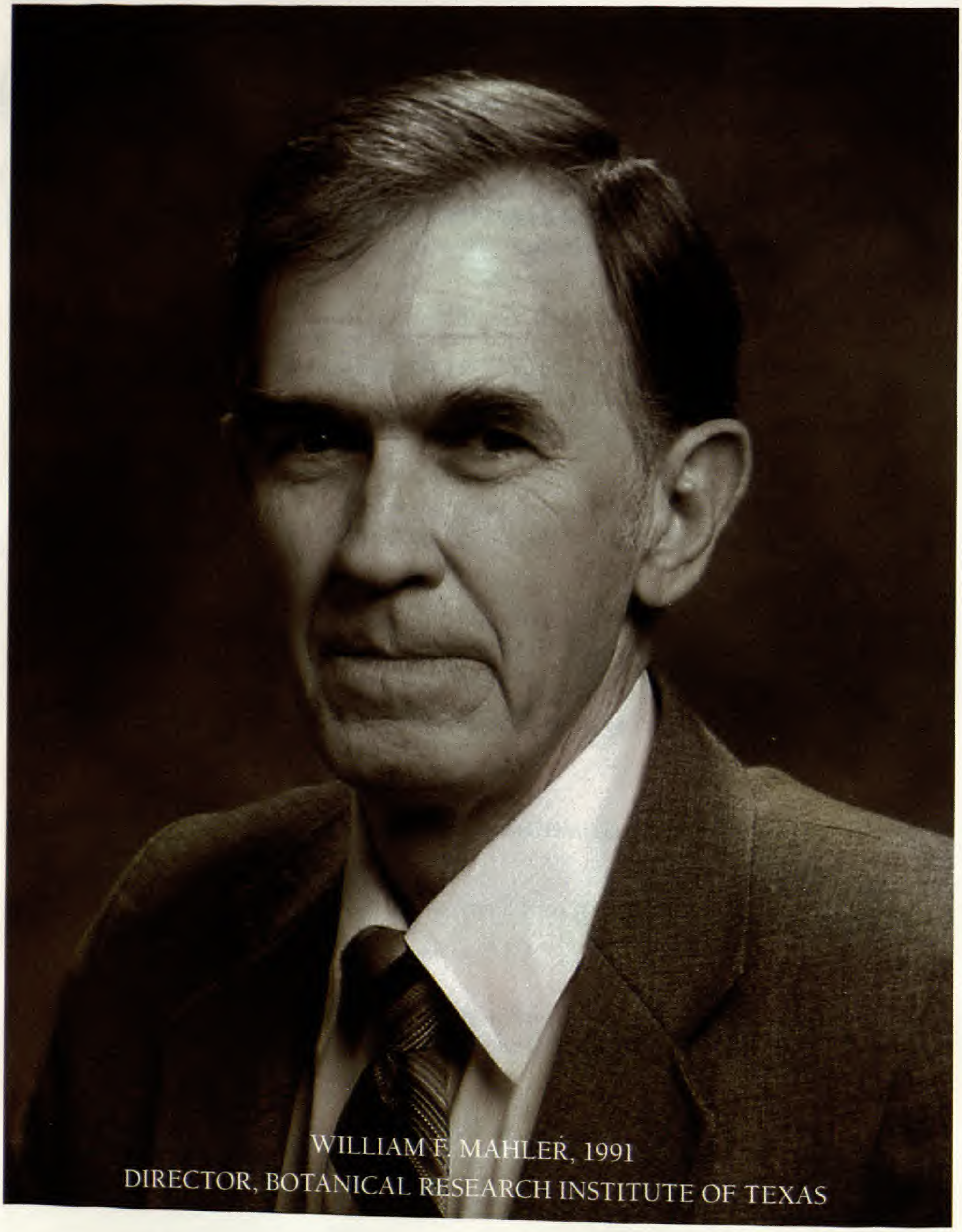


WILLIAM F. MAHLER, 1991
DIRECTOR, BOTANICAL RESEARCH INSTITUTE OF TEXAS

Wm. F. Mahler

IN MEMORY OF BRIT CO-FOUNDER
WM. F. "BILL" MAHLER
1930–2013

VALUED DIRECTOR, MENTOR, VISIONARY, EDITOR, TEACHER, BOTANIST, SUPPORTER, FRIEND
WITH INDEBTEDNESS FOR YOUR MANY CONTRIBUTIONS AND SERVICE TO OUR ORGANIZATION.

The Botanical Research Institute of Texas

WILLIAM FRED MAHLER
"BILL"
30 AUGUST 1930–2 JULY 2013

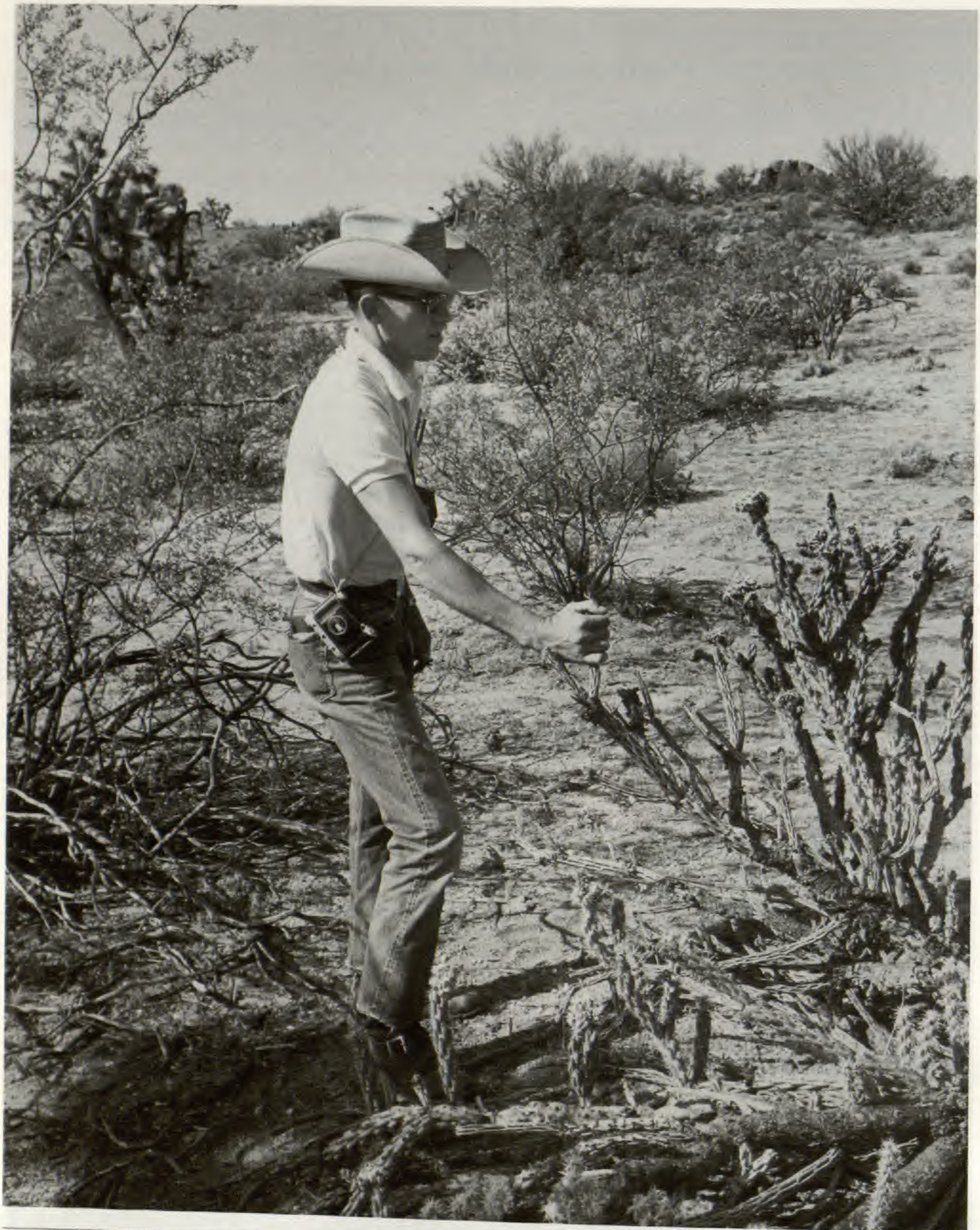
WILLIAM F. "BILL" MAHLER grew up in Iowa Park, Texas, where he was born August 30, 1930. Upon graduation from W.F. George High School in 1947, he enrolled at Hardin College in Wichita Falls, Texas. After three years he enlisted in the U.S. Army instead of enrolling his last year in college and served from September 1950 to September 1953. After basic and advanced training in Headquarters Co., 8th Inf. Reg., 4th Inf. Div., he volunteered for airborne and ranger training. He served with the 14th Ranger Infantry Company (Airborne) at Fort Benning, Georgia, and Fort Carson, Colorado, until they were deactivated in 1951 (Black 1989; Taylor n.d.). In the meantime, the 4th Division had been sent to Friedberg, Germany. He returned to his old company and spent nearly two years in Germany. In 1954, he returned to school and received his B.S. degree in 1955 in Agriculture from Midwestern State University (previously Hardin College) with a major in Soil and Plant Science and a minor in Animal Husbandry. Mahler and Lorene Lindesmith, from Addington, Oklahoma, met in his home town and were married in 1955.

William F. Mahler, ca.1934, approximately 4 years of age. Bill in the back with his brother John in the front.

In 1958 he went to Oklahoma State University (OSU) in Stillwater to pursue graduate work. Mahler received his M.S. degree in Botany/Plant Taxonomy from OSU in 1960, working under U.T. Waterfall. For the next six years he served as an assistant professor at Hardin-Simmons University (HSU) in Abilene, Texas, teaching botany and establishing the HSU herbarium. Subsequently he continued his graduate studies by attending the University of Tennessee at Knoxville where he received a Ph.D. in Botany/Plant Taxonomy in 1968. Upon graduation he joined the faculty of Southern Methodist University (SMU) in Dallas, became editor and publisher of *Sida, Contributions to Botany* in 1971 following the death of L.H. Shinners, and assumed leadership of the SMU herbarium in 1973. Mahler was publisher of *Sida, Botanical Miscellany* after he and Barney Lipscomb founded the journal in 1987. Under his guidance and own collecting, the SMU herbarium grew by 72,000 specimens, eventually reaching about 400,000.

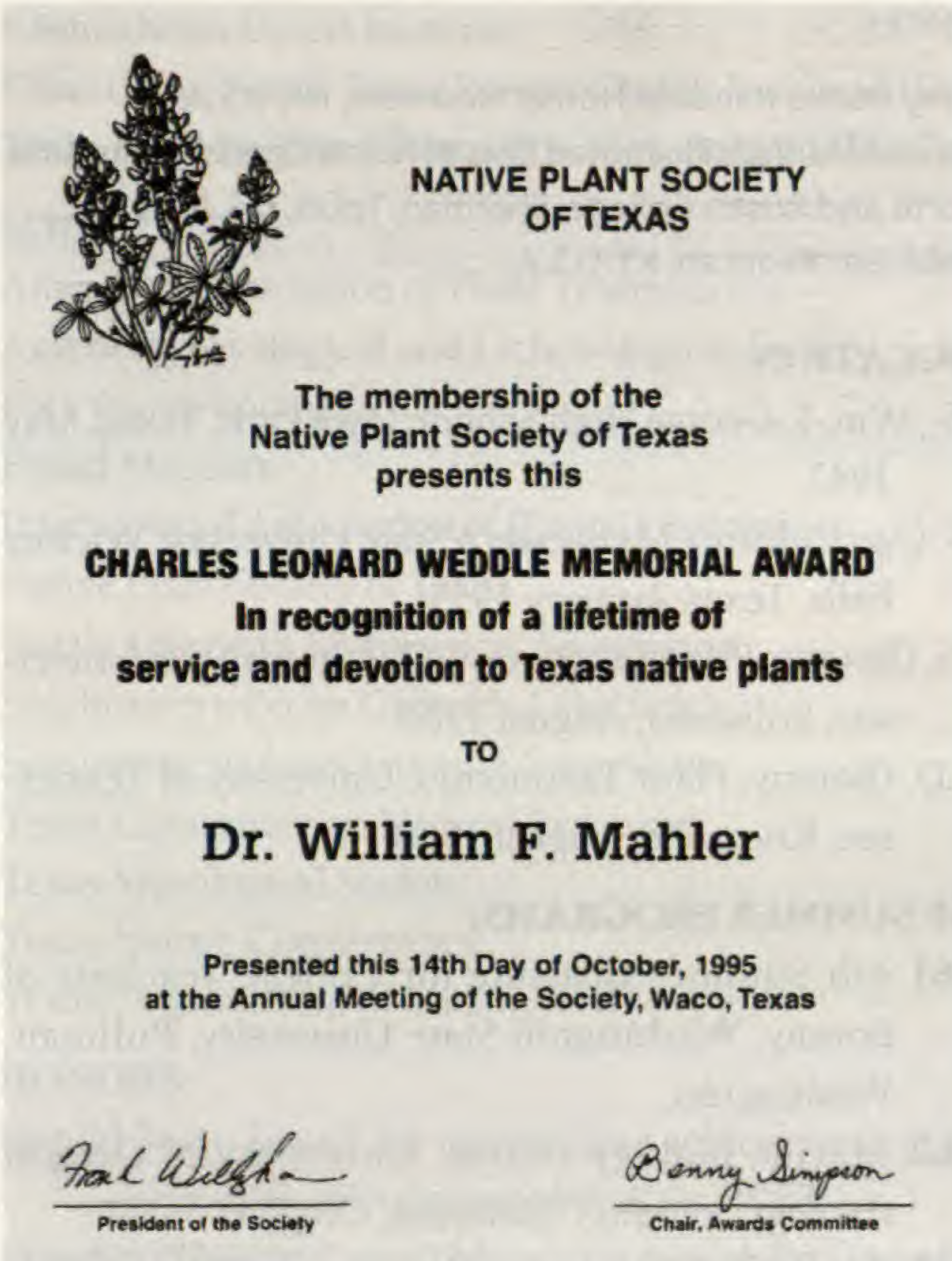
William F. Mahler in uniform 1952. "A studio in Friedberg, Germany, in 1952 had a duplicate in their showcase that was visible from the street. They gave me that copy after a buddy convinced me to go in and ask for it."

J. Bot. Res. Inst. Texas 7(2): 615 – 631. 2013



William F. Mahler, June 1963, age 32. Desert Biology Institute, Arizona State University.

Mahler published *Shinners' Manual of the North Central Texas Flora* (1984, 1988), well known for its clarity and ease of use. The manual, which included the summer and fall flora for North Central Texas, was an expanded version of Shinners' (1958) *Spring Flora of the Dallas-Fort Worth Area Texas*. Mahler received the Donovan Stewart Correll Memorial Award in 1991 from the Native Plant Society of Texas for scientific writing on the


NATIVE PLANT SOCIETY
OF TEXAS

The membership of the
Native Plant Society of Texas
presents this

CHARLES LEONARD WEDDLE MEMORIAL AWARD
In recognition of a lifetime of
service and devotion to Texas native plants

TO

Dr. William F. Mahler

Presented this 14th Day of October, 1995
at the Annual Meeting of the Society, Waco, Texas

President of the Society

Benny Simpson
Chair, Awards Committee

Charles Leonard Weddle Memorial Award, Native Plant Society of Texas, 14 Oct 1995.

William F. Mahler, October 2009, with BRIT colleagues at Native Plant Society Texas Annual Meeting (People and Prairies—Partners) in Wichita Falls, Texas. From left to right: Robert J. O'Kennon, Tiana Rehman, Wm. F. Mahler, and Amanda K. Neill.

native flora of Texas. Other notable publications included the *Keys to the Plants of Black Gap Wildlife Management Area, Brewster County, Texas* (1971), *Flora of Taylor County, Texas* (1973), and *The Mosses of Texas* (1980). Mahler's specialties include Fabaceae, *Baccharis* (Asteraceae), mosses, floristics, pollen morphology, and the study of endangered plant species. In 1988, Mahler was the first recipient of the Harold Beaty Award from the Texas Organization of Endangered Species for his work with endangered plant species in Texas. The Native Plant Society of Texas again honored Mahler in 1995 with the Charles Leonard Weddle Memorial Award in recognition of a lifetime of service and devotion to Texas native plants. Mahler also served on the Board of Consultants for the North Texas Poison Center, Parkland Hospital, Dallas, Texas. He assisted the Poison Center in identifying plants and mushrooms implicated mostly in human poisoning cases.

In 1987 SMU put its herbarium on permanent loan to a newly created organization, The Botanical Research Institute of Texas (BRIT). Mahler received early retirement from SMU (Associate Professor *Emeritus*) and served as the first Director of BRIT (1987–1992). Along with Andrea McFadden and long-time associate Barney Lipscomb, they were instrumental in its establishment as a free-standing research institution.

In 1993, S.H. Sohmer assumed directorship of BRIT, and Bill served as Director *Emeritus* (1993–2013). After retiring, he returned with his loving wife to his childhood home of Iowa Park, Texas, where he enjoyed and shared life experiences with his many friends, family, and grandchildren. He was a native Iowa Parkan and proud of his home town. There he kept his fingers in botany, attended many BRIT functions in Fort Worth (often with Iowa Park friends, introducing them to BRIT), and worked tirelessly on the genealogy of the Mahler family. The taxonomist in him never retired. On July 2, 2013, Bill retired to his final resting place adjacent to his father, mother, and brother in Highland Cemetery, Iowa Park, Texas.

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Taylor, T.H. n.d. Rangers lead the way. Roster, P. 153. Turner Publ. Co., Paducah, KY, U.S.A.

William F. Mahler, 1987, in the SMU Herbarium. Associate Professor of Biological Sciences, Southern Methodist University, Dallas, Texas.

EDUCATION:

H.S., Wm. F. George High School, Iowa Park, Texas, May 1947

B.S. (Agriculture), Midwestern State University, Wichita Falls, Texas, January 1955

M.S. (Botany, Plant Taxonomy), Oklahoma State University, Stillwater, August 1960

Ph.D. (Botany, Plant Taxonomy), University of Tennessee, Knoxville, August 1968

NSF SUMMER PROGRAMS:

1961 4th Summer Institute for College Teachers of Botany, Washington State University, Pullman, Washington.

1962 Marine Biology course, University of Oregon (Biology Station, Charleston, Oregon).

1963 Desert Biology course, Arizona State University, Tempe.

1965, 1966 Research Participation Program for College Teachers, Iowa State University, Ames.

GRADUATE ASSISTANTSHIPS:

Graduate Teaching Assistantship, Botany Department, Oklahoma State University, 1958–1960.

Assistant in Agricultural Biology (Research), Department of Agricultural Biology, University of Tennessee, Knoxville, 1966–1968.

ACADEMIC POSITIONS:

Hardin Simmons University, Abilene, Texas; Assistant Professor, 1960–1966.

Southern Methodist University, Dallas, Texas; Curator, SMU Herbarium 1971–1987; Assistant Professor, 1968–1974; Associate Professor, 1974–1987.

SUMMER TEACHING POSITIONS:

Black Gap Wildlife Management Area, Brewster County, Texas: SMU and Dallas Museum of Natural History, SMU Field Biology Course, 1969–1971.

Fort Burgwin Research Center, Ranchos de Taos, New Mexico: SMU Departmental Courses, 1974–1977, 1979.

NON-ACADEMIC POSITIONS:

Botanical Research Institute of Texas, Fort Worth; Director 1987–1993; Director *Emeritus*, 1993–2013.

MILITARY EXPERIENCE:

U.S. Army, 1950–1953 (14th Airborne Ranger Infantry Company, 4th Infantry Division), U.S.A. and Germany.

ORGANIZATIONAL MEMBERSHIPS:

Adjunct Curator, Dallas Museum of Natural History

Board of Directors, Natural Area Preservation Association

Botanical Research Institute of Texas

Chihuahuan Desert Institute

Consultant, North Texas Poison Center, Parkland Hospital, Dallas, Texas

Texas Plant Recovery Team, U.S. Fish and Wildlife Service

SOCIETIES:

American Association of Plant Taxonomists

American Bryological and Lichenological Society

Fort Worth Botanical Society

Heard Museum

International Association of Plant Taxonomists

Native Plant Society of Texas

North American Mycological Association

Southeastern Pecan Growers Association

Southwestern Association of Naturalists

Texas Committee on Natural Resources

Texas Mycological Society

Texas Nature Conservancy

Texas Organization of Endangered Species

HONORS:

Harold Beaty Award: for outstanding achievement in Endangered Plant Conservation, 1st recipient, Texas Organization of Endangered Species, 1988.

Donovan Stewart Correll Memorial Award: for scientific writing on the native flora of Texas, Native Plant Society of Texas, Kerrville, TX, 1991.

Charles Leonard Weddle Memorial Award: in recognition of a lifetime of service and devotion to Texas native plants, Native Plant Society of Texas, Waco, TX, 1995.

STUDY LEAVE (SABBATICAL):

Fall 1976, Mosses of Texas

Fall 1986, Mycological protocol for North Texas Poison Center, Parkland Hospital

PUBLICATIONS:

Books and Manuals:

1964 General Botany Laboratory Manual. By author. 51 pp.

1966 Keys to the Embryophyta of Taylor County, Texas. Hardin-Simmons University Bookstore, Abilene, Texas, 86 pp.

1971 Keys to the Vascular Plants of the Black Gap Wildlife Management Area, Brewster County, Texas. SMU Bookstore, Dallas ,Texas. Third revision, 109 pp.

1972 Shinners' Spring Flora of the Dallas-Fort Worth Area, Texas. Editor, 2nd edition. Prestige Press, Fort Worth, Texas, 514 pp. (Class use: Tarleton State University, Tyler Junior College).

1972 Keys to the Mosses of Texas. Biology Department, SMU (for class use), 43 pp.

1973 Flora of Taylor County, Texas: A Manual of the Vascular Plants with Selected Sketches. Published by the author, SMU Bookstore, Dallas, Texas, 247 pp.

1975 Keys to the Bryophytes of Texas. SMU Herbarium, Dallas, Texas, 64 pp. (Class use: SMU, Texas A&M University, Angelo State University).

1980 The Mosses of Texas: A manual of the moss flora with sketches. Published by the author, Dallas, Texas, 147 pp. (Class use: Texas A&M University, Angelo State University).

1984 Shinners' Manual of the North Central Texas Flora, SMU Herbarium, Dallas, Texas, 360 pp. (Class use: Austin College, Sherman; Baylor University; Fort Worth Botanical Garden; Fort Worth Nature Center; Greenhills Environmental Center; Southeastern Oklahoma State University; University of Texas-Arlington).

1988 Shinners' Manual of the North Central Texas Flora. Sida, Bot. Misc. 3:1–313. Botanical Research Institute of Texas, Dallas.

Articles:

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Bastien, J.W., W.F. Mahler, M.G. Reinecke, Y. Shu, W.E. Robinson, Jr., L. Horton, and J. Zalles-Asin. 1991. A virgin pharmacopeia: Bolivian-Kallawayan medicinal plants as sources of anti-HIV compounds. Abstracts of the International Congress of Natural Products 32, Abstract P-3.

Abdel-Malek, S., J.W. Bastien, W.F. Mahler, M.G. Reinecke, W.E. Robinson, Jr., and J. Zalles-Asin. 1994. Phytochemical studies of Kallawaya medicinal plants potential anti-HIV Drugs. Abstracts Southwest Regional Meeting of the American Chemical Society 50, Abstract No. 165.

Abdel-Malek, S., J.W. Bastien, W.F. Mahler, Qi Jia, M.G. Reinecke, W.E. Robinson, Jr., Yong-hua Shu, and J. Zalles-Asin. 1996. Drug leads from the Kallawaya herbalists of Bolivia. 1. Background, rationale, protocol and anti-HIV activity. J. Ethnopharmacology 50:157–166.

NEW TAXA AND NEW COMBINATIONS

Asteraceae *Gnaphalium helleri* Britton var. *micradenium* (Weath.) Mahler—Sida 6(1):32. 1975.

Rosaceae *Rubus trivialis* Michx. var. *duplaris* (Shinners) Mahler—Sida 8(1): 211. 1979.

Brassicaceae *Leavenworthia texana* Mahler—Sida 12(1):239. 1987.

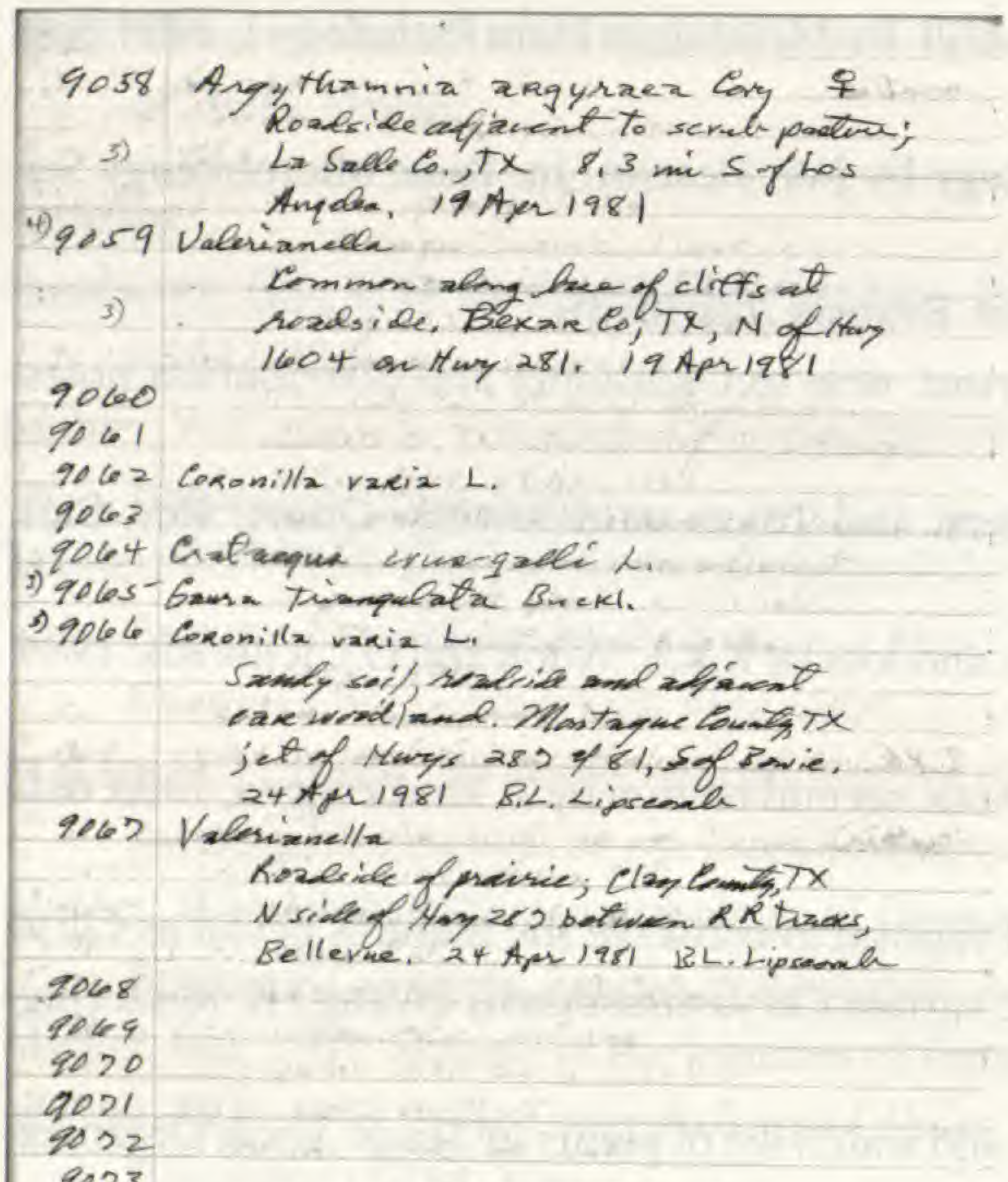
Fabaceae *Pediomelum hypogaeum* Rydb. var. *scaposum* (A. Gray) Mahler—Sida 12(1): 250. 1987 (IK)

Fabaceae *Pediomelum latestipulatum* (Shinners) Mahler—Sida 12(1): 250. 1987.

GRADUATE STUDENTS – M.S.

Olwell, Margaret. 1983. Geobotanical study of *Penstemon cyanocaulis* Payson in Lisbon Valley, Utah. Thesis. December.

Ajayi, Anthonia. 1986. Phaseoleae (Leguminosae) of Oklahoma. Thesis. May.


9058 Argythamnia argyraea Cory ♀
Roadside adjacent to scrub pasture;
3) La Salle Co., TX 8.3 mi S of Los
Angeles, 19 Apr 1981
4) 9059 Valerianella
Common along base of cliffs at
3) roadside, Bexar Co, TX, N of Hwy
1604 on Hwy 281. 19 Apr 1981
9060
9061
9062 Coronilla varia L.
9063
9064 Crataegus crus-galli L.
3) 9065 Gaura triangulata Buckl.
3) 9066 Coronilla varia L.
Sandy soil, roadside and adjacent
oak woodland. Montague County TX
jct of Hwys 287 & 81, S of Bowie.
24 Apr 1981 B.L. Lipscomb
9067 Valerianella
Roadside of prairie; Clay County, TX
N side of Hwy 287 between RR tracks,
Bellevue. 24 Apr 1981 B.L. Lipscomb
9068
9069
9070
9071
9072
9073
9074 Crataegus crus-galli L.
2) 9075 Crataegus crus-galli L.
Granitic outcrops; burned-over area of
slope; Kiowa Co., Okla N side of
Quartz Mtn on S side of Lake Altus.
25 Apr 1981 B.L. Lipscomb

Mahler Field Notebook (8706–9391, Oct 1979–May 1982) showing collection numbers 9066 –9075 (April 1981) with B.L. Lipscomb.

PUBLISHER AND EDITOR

The systematic botany journal, *Sida, Contributions to Botany*, was privately published by Wm. F. Mahler in conjunction with the SMU Herbarium and Library since the death of L.H. Shinners, who founded the journal in 1962. Editor from 1971–1982; publisher from 1971–1993.

The monographic journal, *Sida, Botanical Miscellany* was co-founded in 1987 with Barney Lipscomb and published by Wm. Mahler in conjunction with BRIT.

GRANTS AND CONTRACTS (TO SMU):

1970–1971	SMU Anthropology	$500
1972	SMU Anthropology	$6,000
1979–1982	U.S. Fish & Wildlife Service	$11,200

REPORTS – GRANTS AND CONTRACTS:

Mahler, Wm. F. 1971. Botanical literature survey of the Trinity River Basin. Chapter 2, pp. 35–56. In: J.V. Sciscenti, Environmental and cultural resources within the middle Trinity Basin, Tennessee Colony Reservoir south to Lake Livingston, Int. Rep. Corps of Engineers.

Mahler, Wm. F. 1972. Botanical literature survey of the Trinity River. Chapter 2, pp. 58–129. In: J.V. Sciscenti, Environmental and cultural resources within the middle Trinity Basin, Report to Corps of Engineers, Fort Worth, Texas

Mahler, Wm. F. 1972. Botanical survey of the Lake Monticello area. SMU Contr. Anthrop. 9.1. 25 pp.

FIELD WORK, COLLECTIONS, AND RESEARCH ACTIVITIES:
Mahler 10,201 on 26 July 1990

Primary areas of collecting: Canada (Alberta with Dr. C.D. Bird); Mexico (by way of Chihuahuan and Sonoran deserts with Dr. John W. Thieret), U.S.A. (California, Colorado, Ohio, Oklahoma, Tennessee, Texas)

Mahler at the microscope identifying plants at 509 Pecan Street, Fort Worth, Texas. Fort Worth Magazine 68(3), 1992.

PERSONAL TRIBUTES TO WILLIAM F. MAHLER

Bill Mahler was a new faculty member when I arrived on the SMU campus in 1968. His appearance in faculty meetings was always an occasion to visit with a valuable member of the faculty who was not located in Fondren Science building but in the basement of the Science & Engineering Library. I recall a joint field trip to the Big Bend region of Texas with Bill and several staff members of the Dallas Museum of Natural History, and we were all taken back by Bill's great knowledge of the plants there. We had no idea he was writing a monograph on them. Bill was always a friendly person, eager to share his knowledge of plants.
—John Ubelaker, Biology Department, Southern Methodist University, Dallas

Remembrance for Dr. M.—Dr. Mahler was my graduate adviser at Southern Methodist University in Dallas, Texas, over 35 years ago. I met Dr. Mahler in 1977 when I had just moved to Dallas after getting my undergraduate degree in Botany at University of North Carolina, Chapel Hill. I wanted to talk with him about the graduate program in Botany at SMU. He suggested that I wait one year before coming to graduate school because SMU was hiring 2 more professors with botanical/ecological expertise, and he thought there would be a more well-rounded program for me. As usual, he always thought about what was best for the student. He was absolutely correct, I waited one year and started my classes in 1978 with Dr. Mahler as my graduate adviser. He taught me much about plants, mosses and lichens, pollen, etc., but the thing he taught best was humility. He guided you gently, he listened intently (while squatting), and he never made you feel as though any question you asked was dumb, even if it was! He opened many doors for me professionally, and I am forever grateful. I am sure that the successes I have had as a botanist throughout my career are because of his unwavering belief in my abilities and me.

Dr. Mahler loved plants, especially the flora of North Texas! He understood at a very deep level how important plants are for people, how important the SMU Herbarium was for botanical science, and how important it was to teach people about plants and their significance for humanity. The Botanical Research Institute of Texas is his legacy! I think Texas has lost a true Texan. He was, without a doubt, the best major professor a student could have! He was a gifted scholar, a remarkable teacher, and most of all a truly wonderful human being. It is with great fondness that I remember the venerable Dr. Mahler from Iowa Park. Dr. Mahler, you were my favorite professor of all time and you will be sorely missed!
—Peggy Olwell, Washington, DC

William F. Mahler.—Dedicated educator, passionate, wonderfully sweet man, Dr. Mahler opened up a whole botanical world to his students which we never considered. After taking an elective class in Botany, Dr. Mahler introduced me to the world of mosses and fungi. We traveled all over north Texas and Oklahoma in search of mosses. He worked tirelessly to preserve the SMU Herbarium collection for generations of students. I was one of those many fortunate students blessed by his knowledge and passion for the plant life we studied.

The plant world knows Dr. Mahler as a taxonomist and botanist who was passionate about Texas flora, the SMU Herbarium, and BRIT. But Dr. Mahler was more than an outstanding botanist. He was a good friend, mentor, and surrogate dad. He always had time for his students, and unlike many professors who maintain an academic aloofness from their students, Dr. Mahler was a warm and caring friend who was concerned about his students' welfare not only in the classroom but also outside of the classroom. Dr. Mahler was a man of tremendous character, singularly committed to his work, his family, the Herbarium, and to his home town of Iowa Park. I fondly remember Dr. Mahler quietly encouraging and always positive with pipe in hand. He was the epitome of integrity, honesty, and curiosity.

Someone once wrote, *"A friend should be one in whose understanding and virtue we can equally confide, and whose opinion we can value at once for its justness and its sincerity."* Dr. Mahler was just such a friend. I greatly valued his suggestions as he provided me invaluable advice particularly when I was making a career choice. Although I did not pursue a flora-related career, he supported me as I chose a law career. I, like many of his

students, will be forever indebted to him for his kindness, wisdom, and generosity in sharing his friendship with us. His impact is far reaching. We are all better people for our encounter with this wonderful and generous man.

—Catherine Coats, Dallas

William F. Mahler.—I was saddened when I received a call from Barney Lipscomb saying that Dr. Mahler had died. I enjoyed working with Bill and his group to organize the Botanical Research Institute of Texas in Fort Worth. He was such a kind and dedicated person.

When I think of the Greatest Generation, I think of Bill. God bless you, Dr. Wm. F. Mahler

—David Nivens, Fort Worth

William F. Mahler.—Red-green color-blindness precluded my learning much of Dr. Mahler's vast botanical knowledge, but, as BRIT's chairman during the SMU Herbarium's hunt for suitable quarters in Fort Worth, I was privileged to work with him and want to record a little-known aspect of his crucial role in BRIT's ultimately successful realization of its eco-environmental mission. One month, when funds were temporarily delayed, Bill, who particularly seemed to regard the directors' search effort with wise patience, loaned BRIT the money to assure continued operation. So fortunate that Andrea McFadden got Barney Lipscomb, Bill, Ed Bass, and me together last year [2012] to see BRIT's magnificent new facility and recall its earliest days.

—Lindsay Holland, Midland, Texas

A Tribute to Dr. William F. Mahler.—When I first met Bill Mahler (Dr. M), I was a non-traditional, middle-aged student and he was my botany professor and academic adviser. He was perfect for the job—smart, kind, funny, and patient. Then something happened and the Herbarium collections at Southern Methodist University were placed at risk. So he stepped perfectly into a new role—the stubborn Texan who just would not give up on the SMU Herbarium and Library, a man of courage, persistence, political savvy, and idealism. With steady insistence that the answer to save the Lloyd H. Shinners Collections in Systematic Botany would appear, he recruited a circle of three to the push the cause that later became the Botanical Research Institute of Texas (BRIT). With him at the lead, the collections he loved became the foundational holdings of a growing institution where they could safely serve generations going forward. It was an amazing and wonderful accomplishment by an amazing and wonderful man. On behalf of all of us who love and care for the natural world, I raise a warm and loving tribute to Dr. M. Thank you!

—Andrea McFadden, Seattle, Washington

Dr. William F. Mahler, the SMU Botanist.—I arrived in Texas in late 1972 after accepting a position as pilot for American Airlines. One reason I chose Dallas-Fort Worth was to fly my favorite fighter jet at a U.S. Marine Corps squadron based at the Naval Air Station in Grand Prairie.

Being a lifelong naturalist, I was overcome with the diversity in the Texas flora. I travelled all over Texas in my spare time and collected plants. I was told that the place to have them identified was the herbarium at Southern Methodist University. On my first trip there, I met Bill Mahler. He was able to identify all of my collections. He was curious where I had found these plants since they were considered rare or uncommon. He encouraged me to continue searching for interesting species. Because of Bill's encouragement, I spent more of my time travelling to new places observing the flora and fauna and brought plants for him to identify every few weeks for several years.

Bill invited me to join him in the field on occasion, and I learned much from him. He showed me many new areas and new plant communities. In 1984, we searched for the rare or endangered *Dalea reverchonii*. We found three new sites for the species in Parker and Wise counties. Later, he visited me at my ranch near Fredericksburg in the Hill Country of Texas. He was in search of another rare species, *Amorpha texana* Buckley, now known as *A. roemeriana* Scheele. While searching for days in several counties along creek banks where it was thought to be found, we climbed out of a steep canyon to head home. Bill climbed out ahead of me. As he was near the top of the high creek bank, he grabbed a shrub to pull himself up. It was the *Amorpha* that he had

grabbed. We now knew that the plant did not grow so close to the creek banks as did *Amorpha fruticosa*, but high on the banks above the creeks. Knowing this, we eventually found two more sites.

I worked with Bill and Barney Lipscomb at SMU until the new Botanical Research Institute of Texas was formed in 1987. When we moved to the new location in Fort Worth in 1991, Bill and I supervised the move of the herbarium cases and library books from the herbarium at SMU, and Barney and Andrea supervised the unloading of the trucks at the new building in Fort Worth. Bill stayed on at BRIT for a number of years until retiring.

Bill Mahler was an incredible individual, very intelligent, focused, professional, the consummate gentleman, and admired friend to all. I will never forget the time I spent with him.

—*Robert J. O'Kennon, Fort Worth*

Bill Mahler: A Man to Remember!—One of the reasons I hate getting older is losing friends and people I have known. Bill Mahler was one of those people I hated losing, although I had not seen much of him in the couple or three years before he passed. My lasting impression of Bill will always be when I came to BRIT for the first time in 1992 to interview for the director's position that Bill was stepping down from. I found Bill, Barney Lipscomb, and a couple of other people in a 10,000-square-foot warehouse in what was then "outer Siberia" of downtown Fort Worth. He was a solid, tough guy, with a curmudgeonly and stubborn streak in him, but someone who knew who he was. There are not many people who can qualify as an Army Ranger, but he was one of those. He always seemed to have a cigarette dangling from his lips and used "F.Y.I." ("For Your Information") a lot. Since I also smoked in those days (but gave it up after accepting the director's position of BRIT), he and I would occasionally hang out on the second floor outside stairwell sharing a smoke. What was also startling was that when I saw him at BRIT, I realized that this was the same person I had met when I started graduate work at the University of Tennessee in Knoxville: he was leaving with a fresh Ph.D. and had been an older student having gone back to school after doing his time in Korea. I am certain that the second floor outside stairwell on Pecan Street in downtown Fort Worth, in BRIT's original building, will always have Bill's spirit there that will last much longer than the cigarette butts left behind during his time in that building. Farewell to you, good friend. I will always remember you fondly, and from all of us at BRIT, thank you!

—*S.H. Sohmer, President, Botanical Research Institute of Texas, Fort Worth*

Bill Mahler Leaves a Great Legacy.—Bill helped us create a truly significant and lasting institution. We could not have done what we did with our other board colleagues if it weren't for him. Just think of what a big move it was for Bill to go from tenure at SMU to a warehouse in downtown Fort Worth under the auspices of a bunch of neophytes! He leaves a great legacy [Botanical Research Institute of Texas].

—*Ed Bass, Fort Worth*

Dr. William F. Mahler: My Friend and Colleague—

1975–1981 (The Formative Years of My Career)

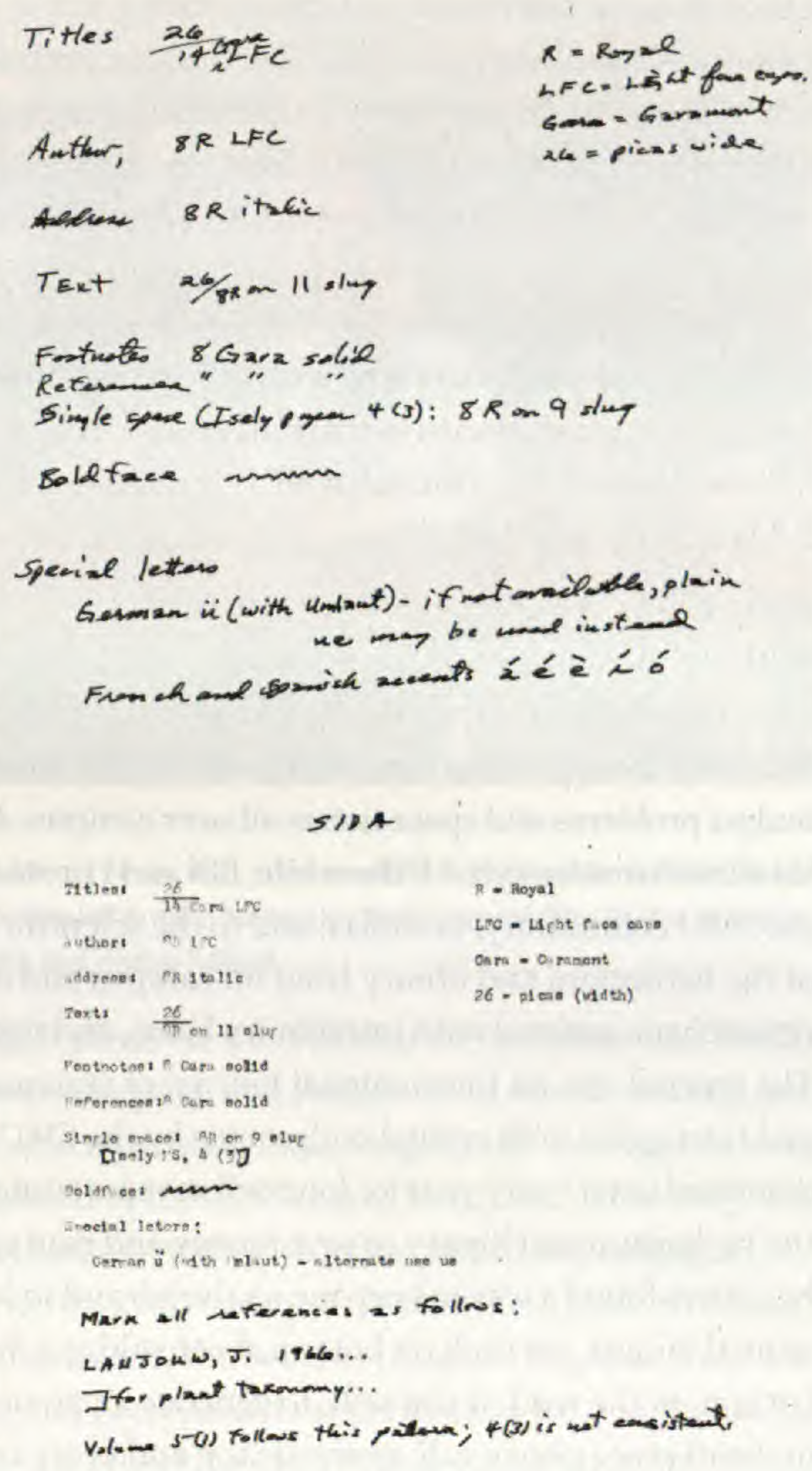
Mr. Robert Ziegler and Dr. Mickey Cooper were professors at Cameron University, in Lawton, Oklahoma, who stimulated my interest in botany and, more specifically, taxonomy of aquatic plants, under Dr. Cooper. In 1973 I was accepted into graduate school in the botany department at the University of Arkansas in Fayetteville. Once on campus, I met Dr. Edwin B. Smith, the taxonomist and discovered the herbarium. In the spring of 1975, I was finishing my master's thesis and was on my way to becoming a botanist. After graduation, I wondered where I would get a job or what path I would follow. Under the direction of my adviser at the University of Arkansas, Dr. Edwin B. Smith, I conducted a floristic survey of the aquatic plants of North Central Arkansas. One of the last things to finish with my thesis was to visit the herbarium at Southern Methodist University in Dallas. Since SMU had the Delzie Demaree Herbarium, an extensive collection of Arkansas plants, studying the Demaree collections was essential for any serious floristic and distributional research on Arkansas plants. Upon arrival at SMU, I met the herbarium botanist, Mr. Jerry Flook, and the director of the herbarium, Dr. William F. Mahler. During the course of my work in the herbarium, I learned about Jerry's imminent departure

from the herbarium for another job. The position of herbarium botanist at SMU would soon be open for applications, and Dr. Mahler invited me to apply. I submitted an application and, lo and behold, on August 20, 1975, I launched my botanical and herbarium botanist career at SMU with some hesitation and trepidation. Dallas, once surrounded by cotton fields, was a big city that seemed far away from the rolling red plains of southwestern Oklahoma, where I was born and raised on a cotton farm near Temple, Oklahoma. I might have felt at home in Dallas a century earlier when it was the world center for the cotton trade, but cotton was in the past in Dallas in 1975. I needed support and guidance in a city of 850,000-plus people. Dr. Mahler was a new boss, but, more important, he was a link to a familiar way of rural life. Dr. Mahler was born and raised in Iowa Park, Texas, a small rural community some 35 miles southwest of Temple, Oklahoma, my birthplace. Bill owned a farm in Oklahoma about 15 minutes as the crow flies from where I grew up—all comforting to a country boy in a big city like Dallas. Dr. Mahler gave me confidence that Dallas would be good for me. So, I lifted my head high, and a lifelong friendship and professional relationship began with Dr. Mahler. I always called him Dr. Mahler until much later in life, when, years after retirement, I simply called him Bill. After all, working side by side in the SMU herbarium and sometimes in the classroom, taking field trips together, attending meetings, enjoying lunch and coffee almost every day, identifying plants together, and simply working with each other for almost 38 years, we were more than colleagues, we were close friends. His family became my family, and in more senses than one, I was a sibling of the Mahler family. I enjoyed everything from dinners at the Mahler home to watching *Monday Night Football* with them. Bill became my botanical mentor, field companion, and a confidant up to his death. The family's home was my home, and after I went through a divorce in 1976, Bill and his sweet wonderful wife, Lorene, along with my own family, were my life support. My life turned out for the better because of Dr. William F. Mahler.

Bill was hired at SMU in 1968 as a three-quarter-time professor in the biology department, located in the Fondren Science Building, and as a one-quarter-time employee of the herbarium, located in the basement of the Science and Engineering Library. Lloyd H. Shinners (1918–1971) was director of the herbarium, and Bill assumed the directorship after Lloyd's death. Fondren Science and the science library were on the north side of the campus, with only a parking lot separating them. Not long after my arrival at SMU, Bill sometimes invited me to assist him with his taxonomy classes, in Fondren, and with labs, usually in the herbarium. The classroom and laboratory interaction with Bill, which was over and beyond my herbarium duties, slowly gave me confidence and a sense of place and purpose. After teaching class in Fondren Science, Bill would return to the herbarium, which he used as his official office. When Bill was away from the herbarium, my life in the basement was often quite isolated from the academic world above ground. Bill was my connection to the academic life at SMU. My daily herbarium activities were regularly interrupted by science library staff looking for herbarium books and journals being requested through interlibrary loan or by the occasional visiting scientist; Delzie Demaree in those early years was a regular visitor. Otherwise, my routine as a herbarium botanist involved a diversity of duties that included processing loans and exchanges, filing Gray Herbarium Index cards, processing and mounting plant specimens, filing specimens, identifying specimens, selecting botanical books for purchase by the library, shelving new books and journals, and overseeing work-study students. Every day, at least during the school year, Bill and I would sit at a table in the herbarium basement and have our lunch, at the very same place where Lloyd Shinners used to sit and sort plants. We discussed everything from Shinners to botanical topics to SMU politics to local and national news. Bill was my advocate at SMU, always looking out for me and trying to improve the quality of my life. My starting salary in 1975 was $7,500 and after six months, I got a hefty $500 raise.

After 12 months or so doing herbarium work, Bill introduced me to the publishing world of botany. In 1976, *Sida, Contributions to Botany*, the journal Bill had inherited from Shinners, its founder and private publisher, was a 15-year-old taxonomic journal. After Shinners died, it was uncertain whether the journal would survive, but indeed it lives today in print and digital formats around the world because of several people, including John W. Thieret, but primarily because of the dedication and perseverance of Bill Mahler. In 1976, the journal was in its sixth volume, and in its early days a volume had multiple issues, sometimes as many as seven.

Sometimes a volume covered multiple years until it reached the desired number of pages. Later, a volume consisted of four issues with two issues per year, and today (as *Journal of the Botanical Research Institute of Texas*), two issues per year make a single volume. Bill was determined to keep the journal alive and privately published *Sida* until 1993, when he gave the copyright to the Botanical Research Institute of Texas upon his retirement as director of BRIT. (*Sida* was renamed in 2007.)



Mahler handwriting, ca. 1975–1976, showing the copyediting and stylistic guidelines for Sida, Contributions to Botany. SMU Herbarium, Dallas, Texas.

Bill invited me to look over his shoulder and learn about reviewing articles and the copyediting process. Today's copyediting, as well as all other phases of publication, are very different from the processes of 1977. I became an apprentice editor at a time when manuscripts were still typed on 8½ × 11 paper and submitted through the postal service (all mail was snail mail). This was truly a time when double-spacing and one-inch margins were critical. Because editing was done in pen, the extra room was essential. When a manuscript was received, it was processed immediately and sent out for review. Based on the review, authors revised and resubmitted their manuscript. Once submitted papers had been reviewed and accepted, they were ready for publication, i.e., taking a typescript manuscript to a printed format. It was time for me to learn copyediting and stylistic guidelines for articles and notes, and to learn proofreader's marks and other marks used in preparing copy for typesetting. Bill was an excellent teacher. In 1976, the text of *Sida* was done in hot type, a process, introduced nearly a century earlier, around 1886, that used molten lead. Type was set with a linotype machine and keystroked line by line, hence the name linotype, which produces a solid "line of type." From the blocks of type that resulted, a set of "galley proofs" was made, which were checked by a proofreader at the printer, as well as by journal editors and the authors, to make sure the type on the page was accurate. The typesetters, or compositors, set the text according to the copyedited and marked-up copy given to them. If there was a mistake anywhere in a line of type, the entire line had to be reset. Everyone needed to be careful, because corrections were costly, and if an error was the author's, he or she paid extra for the corrections. Hence, authors were careful to make sure that a correction affected as few lines of text as possible. Galley proofs were printed on newsprint-like paper, one column wide, from the blocks of set type; a column in a proof could be 24 inches long. Journal pages were mocked up using cut-out sections of the galley proof to create a dummy layout for the paginator at the print shop. There the long, multipage blocks of lead type were arranged according to the dummy. Bill showed me how to make a dummy using three critical elements: 1) a pica ruler (a pica is a measurement used in printing and is equal to ⅙ of an inch), 2) scissors, and 3) rubber cement. I watched Bill carefully measure, mark, and cut long strips of the galley proof into the exact journal page length of 41 picas and paste the "pages" to letter-size paper with Elmer's rubber cement. I got pretty good and almost as fast as Bill at making a mockup from galleys. Once the journal issue had been completely typeset, the errors corrected, and the illustrations properly inserted in the appropriate place, the issue was laid out page by page in printer spreads and printed on a letterpress at the SMU print shop.

I soon became fascinated with this printing world that wasn't too far removed from the form as invented by Johannes Gutenberg in the middle of the 15th century. And to make that moveable type connection even stronger, all I had to do was select a 17th-century herbal, Linnaeus' *Species Plantarum* (1753), or an early issue of *Curtis Botanical Magazine* (1787) from the shelves of Shinners' library and examine or feel the letterpress print on the pages. There is hardly anything quite like the feel of letterpress printing, which was the norm until the mid–20th century, when offset printing was developed.

My herbarium duties were first and foremost, but at every opportunity I assisted Bill with the journal. In 1977, after one year of working with Bill on the journal, he appointed me as assistant editor; I was made full editor in 1982, but still with herbarium duties. In 1987, Bill and I cofounded the monographic book series, *Sida, Botanical Miscellany*. Through it all, I received inspiration and guidance from my colleague and friend, William F. Mahler. He was the light unto my path toward becoming even a semblance of an editor.

Early 1980s (The Struggle for Existence)

With the 1980s came social, economic, and broad change at SMU. Personal computers were introduced but, more significantly, an economic change came, with the housing market crash, the savings-and-loan crisis, and NCAA's "death penalty," canceling SMU's 1987 football season. With all of this happening, there were serious budget problems and space issues all over campus. As a result, the herbarium and library came under a watchful administrative eye. All the while, Bill and I promoted the herbarium and library as an important resource to the SMU community, to Dallas, and to the scientific community at large. We had consistent visitors and users of the herbarium and library from on campus and off. I regularly processed loans of herbarium specimens to researchers, assisted with interlibrary loans, and regularly edited manuscript submissions and published *Sida*. The journal was an international journal of systematic botany and was being distributed internationally. Bill and I struggled with annual budget cuts by the SMU administration, and this included my receiving an annual dismissal letter every year for four or five years straight. SMU was looking at a variety of alternatives for closing the herbarium and library to save money and gain space. Bill was an unflagging optimist and resourceful, and he always found a way to keep me on the job and to keep the SMU Herbarium open for business. To support the annual budget, we took on botanical consulting jobs together, we wrote funding proposals, and took the herbarium on the road, if you will, to generate awareness and support. Those were the days we started recording in detail every phone call, every visitor, and every request on and off campus to provide at least some tangible justification for keeping the herbarium and botany library open and functioning. Bill kept the closure of the herbarium at bay for a few years through contract work, but still that didn't seem to be enough, and by the mid-1980s, budgets were even tighter and space on campus was at a premium. All the efforts to support the herbarium and library ultimately failed, or at least they weren't seen as enough, and SMU started again to seriously consider alternatives for the herbarium and library. Ultimately, SMU placed its herbarium and library on permanent loan first to the Dallas Civic Garden Center and finally to a group of citizens in Fort Worth who had the vision and determination to set up a nonprofit called the Botanical Research Institute of Texas that would accept and care for the Shinners collections.

William F. Mahler, 31 March 2012, at the new BRIT facility, Fort Worth, Texas. Mahler in front. Back from left to right: Lorene Mahler, Andrea McFadden, and Barney Lipscomb.

Thank goodness for failures. Garrison Keillor said to the Harvard chapter of Phi Beta Kappa, "... it is time for you to think about the benefits of failure. Failure is essential, a form of mortality. Without failure, we have a poor sense of reality. In a nutshell,

my advice is Go, and have a crisis," as if to say, one day that will stave off a crisis of greater magnitude. Garrison was right. Those 1980s crises at SMU somehow, some way, prepared Bill and me for reality, and ultimately, with assistance from Bill's student Andrea McFadden, to establish BRIT in 1987 as a free-standing botanical research institution charged with the care and maintenance of the Shinners collections. Through all the ups and downs, Bill was always there to remind me and Andrea that better days were ahead. And they were, thanks to a lot of people and the benefits of failure!

William F. Mahler, 31 March 2012, at the new BRIT facility, Fort Worth, Texas. Mahler in front. Back from left to right: Barney Lipscomb, Lorene Mahler, Andrea McFadden, Edward P. Bass, and Lindsay Holland.

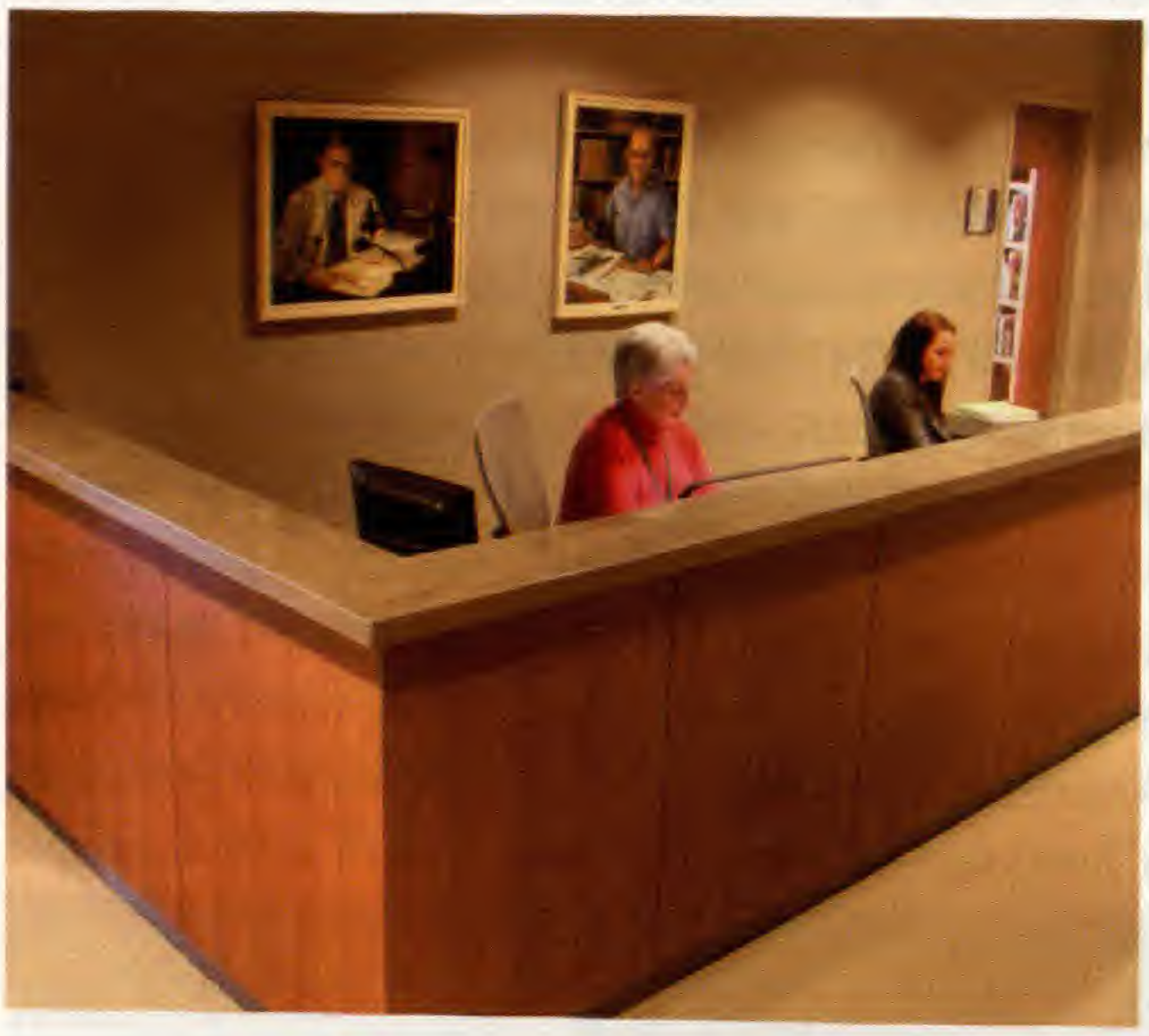
1987–1992 (Brighter Days)

The first 17 years of my botanical career with Bill Mahler at SMU are a source of enduring memories, priceless photos, and roller-coaster rides. I was 25 years of age when I started work at SMU, and I was so impressionable in those early years; Bill's presence was such a positive influence. I fondly remember his personal confidence, persistence, compassion, integrity, and loyalty, all of which touched and influenced my life. I am a better botanist, colleague, editor, and individual for having known and worked with Bill from 1975 to 1987 and even beyond. When BRIT was formed in 1987, Bill retired from SMU. Thus 1987 was a new beginning, and I had the benefit and joy to work another five years with a dear friend and colleague.

After a happenstance meeting in June 1987, with an international real estate broker (Theodore McAlister) and a client of his who had a large tract of Costa Rican timber to sell, the benefits of failure began to truly materialize. At this time, the SMU herbarium and its library had been placed on permanent loan to the Dallas Civic Garden Center, but the arrangement wasn't working out. After that early June meeting with Mr. McAlister, the herbarium and library soon became the basis of the newly formed Botanical Research Institute of Texas. BRIT was established as nonprofit corporation in Texas on October 2, 1987. With a staff of three people and a board of trustees, BRIT was on its way. Bill was director, I was curator/librarian/editor, and Andrea McFadden was executive director. BRIT had a presence in Fort Worth, but the herbarium, library and staff were still housed in the basement of the SMU science library. The search began for a new home in Fort Worth and, through the support of its board, BRIT moved into a turn-of-the-century restored warehouse near downtown. The basis of BRIT at this time was the Lloyd Shinners Collections in Systematic Botany and *Sida*, of which Bill was still publisher and owner. Before the move to Fort Worth, the first two years of BRIT's existence (1987–1989) were formative and trying times for all of the staff and the new BRIT board. There were successes and failures, but surely we would not face another? Our destiny was truly in our own hands. It is hard to see the benefits of failure when you are experiencing crises. Bill Mahler always saw the glass as half full and never let anything really get him down. At one point in the early life of BRIT, the payroll could not be met, and yes, none other than Bill, lent money to the fledgling institution so work could continue. Years later Bill was repaid. He always believed there were brighter days ahead, and it was so, and Bill got to enjoy and see the future of BRIT in its new building, which opened in 2011. In February 1993, Dr. Sy Sohmer assumed directorship of BRIT and Bill became director *emeritus*. Bill and Lorene retired to his hometown, Iowa Park. Iowa Park was on the route I took to visit my family in Oklahoma, and that meant an occasional visit with Bill there.

My day-to-day interaction with Bill ceased with his second retirement, in 1992. Aside from my visits with Bill in Iowa Park, I got to see him regularly in Fort Worth at BRIT events. In 1995, BRIT began an annual fund-raising banquet that came to be called the Annual Award of Excellence in Conservation, and from 1995

William F. Mahler, 1993. Portrait by Dennis Farris with setting at BRIT, 509 Pecan Street, Fort Worth, Texas. Portrait hangs in the new BRIT Research Library, 1700 University Dr., Fort Worth, Texas.



Portraits of William F. Mahler (left) and Lloyd H. Shinners (right) in the BRIT Research Library, 1700 University Dr., Fort Worth, Texas.

through 2009 Bill and his wife were guests at the gala. He and Lorene purchased tickets and often brought friends to Fort Worth to join them; Bill and his wife were always recognized at the event. The years of hard work, along with the trials and tribulations that came with keeping BRIT alive and going forward, were truly recognized. Over the years, Bill slowed down, and, in 2010 he was unable to make the trip. I'll never forget attending the 2010 banquet and not seeing Bill and his wife there. I took home with me one of the beautiful floral table arrangements and made a visit the very next day to Iowa Park. I proudly gave Lorene the floral arrangement and a copy of the program, and enjoyed my visit with them. The 2009 Annual Award of Excellence in Conservation may have been Bill's last formal BRIT function, but Bill was destined to make two more ever-important trips to BRIT from his Iowa Park home before his passing on July 2, 2013.

2011 (A Dream Fulfilled)

Even before BRIT moved to Fort Worth in 1991, Dr. Mahler and the entire BRIT board was looking to the future beyond its newly leased space near downtown Fort Worth. When Dr. Sohmer arrived as director in 1993 he began to set his vision on moving BRIT into newer facilities. Even the BRIT board realized that a new and permanent space was essential to BRIT's mission. In short, with lots of planning, a new location was selected in the Fort Worth Cultural District adjacent to the Fort Worth Botanic Garden. And finally, after years of planning and design, a new LEED Platinum Certified building was built, which opened to the public in 2011.

Attending the ever-memorable grand opening of BRIT's new facility in 2011 was a crowning moment for Bill, his family, the BRIT board and staff, and every supporter. There was excitement all around. The new green building was more than anyone had dreamed, more than anyone could have envisioned on October 2, 1987, the day it was established as a nonprofit. Since then, almost 27 years ago, it was a dream of the early founders, supporters, board members, and staff that one day the BRIT collections would move to the dynamic Fort Worth Cultural District. For all of us, but especially for Bill and his family, May 15, 2011, will be a day to remember. He was proud of BRIT, and everyone was proud of Bill and his perseverance.

The last day Bill visited BRIT was March 31, 2012, with his family by his side. Bill was still of sound mind and spirit but needed a little help getting around. It was a very special day that will live forever with him, his family, and BRIT friends. It was a reunion of the two early board members Lindsay Holland (from Midland), the first president of BRIT, and Ed Bass (from Fort Worth), vice president of BRIT, Andrea McFadden (from Seattle), BRIT's first executive director, and me (curator/editor/librarian). It was a homecoming that started with a wonderful lunch in a new boardroom and concluded after two hours of touring and talking about the

new BRIT. We shared stories about BRIT's early years at SMU and its first home in Fort Worth (Tindall Warehouse, a restored turn-of-the-century building), where it was located from 1993 until 2011).

My memory of Bill lives on, and I'll be forever grateful for what he gave me. His memory at BRIT is reflected in more ways than one. His portrait hangs in the BRIT library adjacent to that of Lloyd Shinners, whose collections are the heart and soul of the Botanical Research Institute of Texas. It almost never fails that when I walk into the BRIT library, I look over at Bill and Lloyd and smile, and in my heart, I say, "Well done, thou good and faithful servants. Thank you."

—Barney L. Lipscomb, Fort Worth

BOOK REVIEW

ANDY MACKINNON AND JIM POJAR. 2013. **Alpine Plants of the Northwest: Wyoming to Alaska.** (ISBN-13: 978-1-55105-892-4, pbk.). Lone Pine Publishing, 1808 B Street NW, Suite 140, Auburn, Washington 98001, U.S.A. (**Orders:** www.lonepinepublishing.com, order@lonepinepublishing.com, 1-800-518-3541). $29.95, 528 pp., 5 ½" × 8 ½".

Pojar and MacKinnon have created the format for field guides by which all others are measured. *Alpine Plants of the Northwest: Wyoming to Alaska* follows in the footsteps of previous volumes in regard to the content, layout, and presentation. The only shortcoming may be in the breadth of the material. From an ecological perspective, it makes sense to cover a region stretching from far northern Alaska southeast through the Cascade Range and the continental divide to Wyoming. From the perspective of a hiker seeking to balance weight with knowledge, the book may stretch half a continent too far. For an armchair ecologist, however, there is no better guide to the cold-climate plants of the Pacific Northwest.

For a non-technical field guide, the Pojar and MacKinnon books offer a spectacular balance of usability and detailed information on taxonomy. For the truly novice, the book offers a plethora of well-composed photographs. Each portion of a plant that is most distinctive is highlighted as needed, from flowers to leaf shapes to canopy outline for trees. Many guidebooks stop short at one or two photographs of a flower, leaving the user out of luck should the trailside specimen be poor quality. For the more sophisticated user, the Pojar and MacKinnon guides are organized by family with non-technical dichotomous keys emphasizing easily field-discernible characteristics within each section.

The importance of a well-constructed key, organized by easily visible characteristics and supplemented with multiple high-quality photographic illustrations, cannot be overstated. Further, the text description includes significant characteristics that distinguish a taxon from closely related or easily confused groups. Finally, each entry includes a map showing the approximate distribution of the species. Even experienced botanists more familiar with the flora of other ecoregions will find books by Pojar and MacKinnon invaluable.

From a simple physical perspective, the Pojar and MacKinnon guidebooks are constructed of high-quality, water-resistant paper (a necessity in any PNW field guide!). The bindings are sewn, with the anticipation that the guide will be well-thumbed and frequently used. Finally, each book strikes a good balance between page dimensions (larger pages mean more room for photographs) and portability (smaller dimensions mean less space). The weight of the paper adds some heft to the finished product, but this inconvenience is well worth the additional life span of the tome.

Although not so useful for identification, short snippets of ethnobotanical information are included for many plants. This supplemental information on traditional First Nations names and uses for many of the plants, whether edible or medicinal, contributes to the overall sense of each plant species as an element of an ecosystem.

Perhaps the most admirable element of Pojar and MacKinnon's guides is their usefulness to the amateur naturalist looking to learn more about a flora. The approachability and accessibility of the guide makes it very useful to the inexperienced. The more detailed information about flower morphology and the characteristics that distinguish common families in the Pacific Northwest provides an excellent opportunity for the enthusiast to learn the basis by which plants are classified.

As stated initially, the only significant drawback of this guide is its heft for those hikers wishing to cut every ounce, but the breadth of territory covered necessitates a substantial volume. This approach may be desirable from an eco-regional perspective—and from the additional expense that would presumably follow state-specific books. From the perspective of an interested naturalist who values knowledge over convenience, however, there is really no substitute. Aspiring field guide authors from other regions of the US would do well to emulate the Pojar and MacKinnon formula.—*Brian Witte, PhD, Botanical Research Institute of Texas Research Associate, Adjunct Professor of Biology at Collin College, and freelance writer.*

FOUR NEW ANNUAL SPECIES OF *EUPHORBIA* SECTION *TITHYMALUS* (EUPHORBIACEAE) FROM NORTH AMERICA

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ABSTRACT

Four new annual species of *Euphorbia* section *Tithymalus* (subgenus *Esula*) are described. **Euphorbia austrotexana** is endemic to Texas; **E. georgiana** is endemic to Georgia; **E. nesomii** is from the state of Nuevo Leon in Mexico; and **E. ouachitana** occurs in the states of Arkansas, Missouri, Oklahoma, Tennessee and Texas. In addition, *E. austrotexana* is described with two varieties: **E. austrotexana** var. **carrii** and the nominate *E. austrotexana* var. *austrotexana*. All known collections of these new species post-date the taxonomic treatment of Norton at the turn of the 20th century. The distributions, ecology, and comparative details of these new taxa are described and discussed. Chromosome counts are reported for *E. austrotexana* var. *austrotexana*, *E. longicruris*, *E. peplidion* and *E. roemeriana* and compared with existing reports for species of North American members of section *Tithymalus*. A key including all native North American non-perennial species of section *Tithymalus*, as well as similar, common, non-native congeners is provided.

RESUMEN

Se describen cuatro nuevas especies anuales de *Euphorbia* sección *Tithymalus* (subgénero *Esula*). **Euphorbia austrotexana** es endémica de Texas; **E. georgiana** es endémica de Georgia; **E. nesomii** del estado de Nuevo León en México; y **E. ouachitana** se da en los estados de Arkansas, Missouri, Oklahoma, Tennessee y Texas. Además, *E. austrotexana* se describe con dos variedades: **E. austrotexana** var. **carrii** y la nominada *E. austrotexana* var. *austrotexana*. Todas las colecciones conocidas de estas nuevas especies posdatan el tratamiento taxonómico de Norton a la vuelta del siglo XX. Se describen y discuten las distribuciones, ecología, y detalles comparativos de estos nuevos taxa. Se citan recuentos cromosomáticos de *E. austrotexana* var. *austrotexana*, *E. longicruris*, *E. peplidion* y *E. roemeriana* y se comparan con citas existentes de especies de Norte América miembros de la sección *Tithymalus*. Se aporta una clave que incluye todas las especies no perennes nativas de Norte América de la sección *Tithymalus*, así como congéneres similares, comunes, no-nativos.

KEY WORDS: Chromosome numbers, *Euphorbia*, Euphorbiaceae, floristics, seed morphology, taxonomy

INTRODUCTION

North American species of *Euphorbia* L. include members of three of the four major clades discovered and corroborated by numerous recent phylogenetic studies (e.g., Steinmann & Porter 2002; Bruyns et al. 2006; Horn et al. 2012). Among those clades, the one circumscribed as *Euphorbia* subgenus *Esula* Pers. is highly diverse in the Old World (>400 spp.), while in the New World (<50 spp.) it is primarily represented by *Euphorbia* section *Tithymalus* (Gaertn.) Roep. The taxonomic limits of section *Tithymalus* were recently refined by Riina et al. (2013): with the new circumscription this section is unique within subg. *Esula* in that most of its diversity occurs in the New World, with 35–40 species of annual and perennial herbs. All of the members of section *Tithymalus* share a lack of stipules, cyathial glands having either horns from the lateral margins, or having marginal crenae (with or without long horns), seeds with conspicuous caruncles and smooth to variously pitted or reticulate seed surfaces. The most recent complete taxonomic revision for North American species of this group was by Norton (1899), who treated all taxa north of Mexico belonging to section *Tithymalus* (sensu Boissier [1860], with nearly the same constitution as the contemporary subg. *Esula* sensu Riina et al. 2013). Geltman et al. (2011) recently updated the nomenclature including a novel synonymy and lectotypifications for essentially the same set of taxa (i.e., *Euphorbia* subgenus *Esula* sensu Riina et al. 2013) "… as a precursor to the treatment of *Euphorbia* for the Flora of North America." The latter made no taxonomic changes (other than lectotypification) to the suite of short-lived taxa of the revised sect. *Tithymalus* relative to the same species in

Norton's treatment.

The annual North American members of section *Tithymalus* (not including *E. commutata* and *E. crenulata*, which are usually biennials) are much less well known and more restricted in distribution in comparison to the non-annual taxa, and they have been more stable taxonomically. From the time of Norton's (1899) treatment to now, these have included five species within the southern central U.S. states of Arkansas, Kansas, Louisiana, Oklahoma, and Texas. Notably, all five species occur primarily or exclusively in Texas wherein three are endemic and two are chiefly distributed (Correll and Johnston 1970; Turner et al. 2003). These species have strong ecological affinities and clear separations in morphology and geography (Berry et al., *Flora of North American North of Mexico*, submitted). Most conspicuous among these is the relatively robust *E. roemeriana* Scheele, endemic to the shaded canyonlands of the Balcones Escarpment of Central Texas. It is highly branched, bearing conspicuous yellow-green, horizontal subcyathial bracts ("raylet leaves" in Riina, et al 2013), and having seeds with reticulate ridges. The remaining four species are more sparingly branched from the base, and have raylet leaves that are greenish and are held at an oblique angle or perpendicular to the horizontal (directed away from the axis of the plant). *Euphorbia helleri* Millsp. occurs on clayey soils near the Texas coast from the lower Rio Grande Valley to the Coastal Bend area, and inland to Gonzales and Karnes Counties (reports from Louisiana [e.g., Thomas & Allen 1996] were misidentified). *Euphorbia longicruris* Scheele occurs sparsely across a broad swath of the central Texas Hill Country to the southern half of Oklahoma's prairies on thin soils over limestone and sandstone outcroppings, and in the Ouachita Mountains to Hot Springs, Arkansas, on gladey shale outcrops. *Euphorbia peplidion* Engelm. is most prevalent in the Coastal Bend area, but ranges widely from there north to Travis County, and west to eastern Pecos and Val Verde Counties (the latter not indicated by Turner et al. [2003]). It grows in margins of eastern post oak, in Tamaulipan thornscrub, live oak sandylands, and adjacent to coastal scrublands, where it seems to prefer silty or sandy soils over limestone. Although it has yet to be collected from Mexico, from an ecological perspective, it is one of the more likely of these species to have a natural distribution yet to be discovered there, as speculated by Johnston (1975). Lastly, *E. tetrapora* Engelm. is here considered to be endemic to the western Gulf Coastal Plain from central Louisiana to Wilson County, Texas, and north within the Cross Timbers to southern central and southeastern Oklahoma (I have seen no specimens that can reliably be placed from east of the Mississippi River [e.g., "*Boykin, Georgia*", Engelmann 1858] and it has never been well-documented from there). It occurs in loose, sandy soils in openings in mixed upland savannah woodlands with post oak (or sand post oak), often with loblolly pine.

This study presents four previously undescribed annual species and one variety within *Euphorbia* section *Tithymalus* (sensu Riina et al. 2013). Field and herbarium work by the author on New World *Euphorbia*, including access to collections not available to earlier authors, has enabled discernment of this diversity. This work advances understanding of diversity in New World *Euphorbia*, and lays groundwork for broader, phylogenetic study of section *Tithymalus* (Peirson et al., in prep).

NEW SPECIES DESCRIPTIONS

Euphorbia austrotexana M.H. Mayfield, sp. nov. (**Fig. 1**). Type. UNITED STATES. Texas. Atascosa Co.: along FM 476, 5.2 mi N of Rossville from jct. FM 2405, 0.2 mi S of Hartung Road, [elev.] 719 ft, N29°09'55", W98°40'55", 4 Apr 1993, *M.H. Mayfield 1717, with J. Mendenhall & J. Panero* (holotype: TEX; isotypes: BRIT, DAV, F, GH, KSC, LSU, MICH, MO, NY, PH, RSA, TAES, UC, US).

Similar to *Euphorbia longicruris* Scheele, but differing in the smaller in stature, with narrower, almost linear leaves, and seeds 1.4–1.7 mm long, rotund-ovoid and covered with minute crowded, concave depressions.

Glabrous annual herbs with taproots, 6–25(–28) cm tall, stems erect, 1 to a few stems spreading from the base. Stem leaves alternate, sessile, strongly ascending to divergent (with age) above, blades 5–18 mm long, 0.8–2.5 mm wide at the widest point, narrowly oblanceolate to nearly linear, less often somewhat spatuliform, bases linear to linear-attenuate, apices rounded to obtuse or acute. Ray leaves 3, sessile, 5–33 mm long, 1.5–3.0 mm wide, narrowly oblong to narrowly lanceolate. Primary inflorescence rays 3, usually with 1 to 3 internodes from 1.5–3.5 cm long, upper nodes becoming monochasial, secondary rays 0 to 3 in the upper mainstem leaf axils. Raylet leaves free at the base, 3–8(–13) mm long, length/width ratio 0.7–1.5(–3.0), reniform-ovate to subdeltate-ovate, rarely broadly lanceolate, bases obliquely truncate to rounded, apices broadly acuminate to

Fig. 1. The holotype of *Euphorbia austrotexana: Mayfield 1717* (TEX).

attenuate, blades oriented vertically, adaxial surface directed away from the plant axis. Cyathia: involucres funnelform, 0.8–1.0 mm high, 0.6–0.7 mm wide, on a stalk 0.1–0.2 mm long; cyathial glands lunate, 0.3–0.4 mm wide, horns 0.5–0.7 mm long, relatively stout and blunt, entire to rarely slightly bifurcate at the apices, the margins entire between the horns, involucral lobe apices rounded, short-ciliate on the margins; staminate flowers 5 to 10. Pistil: styles 3, ca. 0.3 mm long, free nearly to the base, bifid at the apices for ⅓–⅔ of the length, the lobes divergent and spreading away, capitate. Capsules 2.0–2.2 mm long, 3.0–3.2 mm wide, columellas 1.8–2.0 mm long. Seeds 1.4–1.7 mm long, 1.0–1.3 mm wide, rotund-ovoid, rounded in cross-section, surface ashen-gray to whitish at maturity, with deep, irregular to rounded, concave depressions crowded over the entire surface; caruncles 0.7–0.8 mm wide, reniform-ovate, stipe present.

Etymology.—This plant is named for the region in which it occurs.

Chromosome number.—n = ca. 12–13 II (reported here, below).

Additional specimens examined (var. *austrotexana*): **U.S.A. TEXAS. Atascosa Co.:** E side of northbound exit 113 ramp on IH-37, ca. 3.5 air mi ESE of Leming and 1.2 mi E of Gallinas Creek, 460 ft, [corrected coordinates: N 29°02'59" W 98°25'52"], 22 Mar 1992, *M.H. Mayfield & M. Phaneuf 1170* (KSC, LSU, MICH, TEX), also 20 Mar 2010, *M.H. Mayfield et al. 3843* (KSC, LSU, MICH, TEX); Exit 113 on southbound Interstate 37, E of onramp, S of Brite Cemetery Road, 460 ft, [corrected coordinates: N 29°03'06" W 98°25'59"], 29 Mar 1992, *M.H. Mayfield & M. Phaneuf 1173* (LSU, MICH, TEX), also 26 Mar 1995, *M.H. Mayfield & C.J. Ferguson 2160* (LSU, TEX). **Bexar Co.:** W side of IH-37, ca. 500 ft N of mile marker 124, 1.3 roadmiles N of overpass at Priest Road-Mathis Road exit, 29°12'00"N, 98°25'12"W, 560–570 ft, 20 Mar 1993, *W.R. Carr & M. Mayfield 12504* (BRIT, KSC, LSU, MICH, TENN, TEX, UARK), also 13 Mar 1995 *M.H. Mayfield 2128* (BRIT, LSU, TEX, UARK); U.S. Hwy 281, S of San Antonio, 4.1 mi N of jct. with 536 (in Espey), 650 ft, 29°09'59"N, 98°28'56"W, 13 Mar 1994, *M.H. Mayfield, C. Ferguson, & A.L. Hempel 1874* (LSU, TEX); 0.6–0.7 road mi ENE of I-37 [at exit 122] on E side of Priest Road, S end of county, 620 ft, 29°11'15"N, 98°24'53"W, 4 Apr 1993, *M.H. Mayfield, J. Mendenhall & J. Panero 1720* (BRIT, KSC, LSU, MICH, TEX). **Wilson Co.:** Gene Dodgen property, E side of FM [road] 1303. *W.R. Carr et al. 13345* (TEX).

Populations of this species occurring on the South Texas sand sheet are recognizable as a distinct variety, with the following key to distinguish them from the typical variety. Some of these plants were taken by Turner (2011) to be evidence for the persistence of *E. exigua* L. in Texas; the latter taxon, an introduction from the Old World, belongs to a separate section, *E.* sect. *Exiguae* (Geltman) Riina & Molero, and can be readily distinguished by its seeds with tubercular prominences (Fig. 2).

1. Plants generally 6–13 cm tall, with 3 or more subequal, virgate stems from the base; stem leaves divergent, linear to scarcely lanceolate, apices acute; raylet leaves 8–15 mm long, broadly ovate-lanceolate, bases rotund; seeds 1.4–1.5 mm long, 1.0–1.1 mm wide, surface pit shape irregular, the depressions not smoothly concave; plants from the south Texas sand sheet, Jim Hogg and Kenedy counties, Texas ____ **E. austrotexana** var. **carrii**
1. Plants generally 10–25 cm tall, with 1 dominant and 2 to 4, subdominant more or less erect stems from the base; stem leaves erect-ascending, linear-oblanceolate, apices rounded; raylet leaves 3–7 mm long, reniform-ovate to subdeltate-ovate with a short-acuminate apex, the bases truncate; seeds 1.6–1.7 mm long, 1.1–1.3 mm wide, surface pit shape regular, the depressions smoothly concave; plants from the southwestern extreme of the Post Oak belt in Atascosa, Bexar, and Wilson counties, Texas ____ **E. austrotexana** var. **austrotexana**

Euphorbia austrotexana var. **carrii** M.H. Mayfield, var. nov. (**Fig. 3**). Type: UNITED STATES. Texas. Kenedy Co.: 50–200 ft W of a major N-S pipeline clearing on Hunke Ranch, 0.6 mi N of a major internal fence, 1.2–1.3 air mi W to WNW of jct. of Hidalgo, Kenedy, and Willacy counties, 50 ft, 16 Mar 2004, *W.R. Carr & M. Pons 22784* (holotype: TEX).

Like E. austrotexana var. austrotexana but different in its smaller stature, usually having 3 or more subequal virgate stems, raylet leaves ovate-lanceolate (1.5 times longer than wide), and seeds smaller, with more compact pits in the surface.

Euphorbia austrotexana occurs in stabilized sandy soiled habitats, with a range extending through a wide swath of the south Texas plains. Although it is apparently locally abundant in some cases, only five documented localities for var. *austrotexana* are known. One of these is on Queen City Sand formation (both sides of I-37 around Exit 113, Atascosa County), while the other four population areas are on a particularly massive representation of the Carrizo Sand formation between Devine (Atascosa County) and the San Antonio River (Wilson County). Numerous searches criss-crossing the Carrizo Sand on the east side of the San Antonio River in suitable post oak/blackjack sandy savannah only yielded *E. tetrapora* in the southwestern-most part of its distribution. The populations of *E. austrotexana* var. *carrii* are scattered across the south Texas Sand Sheet, an area

FIG. 2. Seeds of the species published here with representative annual species of *Euphorbia* section *Tithymalus*. Seeds are presented in pairs, with the dorsal face on the left and ventral face on the right with voucher and geographic source information (herbarium in brackets). From left to right—**top row:** *E. longicruris*, Oklahoma, Roger Mills Co. (*Taylor & Ballman 2572* [OKL]); *E. longicruris*, Arkansas, Hot Springs Co. (*Mayfield & Ferguson 3127* [KSC]); *E. exigua*, Poland, Tunel, Miechów County (*Wayda s.n.* [KSC])—**second row:** *E. georgiana*, Georgia, Oglethorpe Co. (from the holotype [GA]); *E. tetrapora*, Texas, Robertson Co. (*Hardin 536* [US]); *E. ouachitana*, Oklahoma, McCurtain Co. (*Mayfield & Ferguson 3108* [KSC])—**third row:** *E. austrotexana* var. *austrotexana*, Texas, Atascosa Co. (from isotype [KSC]); *E. austrotexana* var. *carrii*, Texas, Kenedy Co. (from the holotype [TEX]). *E. nesomii*, Mexico, Nuevo Leon, Municipio Higueras (from isotype [KSC])—**bottom row:** *E. commutata*, Wisconsin, Rock Co. (*Wadman 15639* [PENN]), *E. commutata*, Tennessee, Polk Co. (*Sherman s.n., 20 May 1959* [TENN]), *E. commutata*, Florida, Jackson Co. (*Godfrey 53170* [NY]).

of recently formed eolian sands. The plants seem to occur in the deepest sand areas of this region in Mesquite Savannah (El Canelo and Hunke Ranches) and in "tanglehead-buffelgrass grassland on reddish sandy loam" (quoted from *Carr 25500*).

The earliest confirmed record of *E. austrotexana* is from 1992 (*Mayfield 1170*), although it may have been collected once previously from near Flour Bluff, Texas (28 Mar 1959, *F.B. Jones 2925* [WWR, held at the Corpus Christi Museum]). The latter specimen includes a plant of *E. peplidion* and three plants of another species that could be either *E. exigua* or *E. austrotexana*. However, the specimen could not be obtained on loan, and digital images obtained were insufficient to make a definitive determination.

Etymology.—This taxon is named to honor one of the most active botanists in Texas' recent history: William R. Carr. His thoughts and tremendous collecting efforts with respect to this and many other projects have greatly advanced the field of floristics and conservation in Texas.

Fig. 3. The holotype of *E. austrotexana* var. *carrii*: *Carr & Pons 22784* (TEX).

Additional specimens examined (var. *carrii*): **U.S.A. TEXAS. Jim Hogg Co.:** ca. 0.9 air mi S of Balderas Windmill, 1.2 mi N to NNW of El Nuevo Windmill, Eshelman-Vogt Ranch, SE of Hebbronville, at N27°16'12.6", W98°36'38.5", elev. 480–490 ft, 13 Mar 2007, *W.R. Carr et al. 25500* (TEX 00167463). **Kenedy Co.:** El Canelo Ranch, N side of E-W stretch of road leading to 'Broken Windmill,' ca. 0.3 mi W of that windmill and ca. 0.5 mi NNE to NE of HQ compound, elev. 35–45 ft, 26°40.038'N 97°49.703 W, 7 Mar 2002, *W.R. Carr 20435* (TEX); ca. 0.1 mi W to WNW of the Broken Windmill, ca. 0.8 NE of HQ compound, 26°40.086'N 97°49.316 W, 8 Mar 2002, *W.R. Carr 20440* (TEX); 0.6 mi NE (51°) of El Canelo Ranch building complex, N 26.66879° W97.82212°, 20 Mar 2010, *Mayfield et al. 3839* (KSC); medium [sic] of hwy 77, 6 mi S of hwy 628 and N of Sarita, 15 Mar 1993, *L.E. Brown 16768* (SBSC).

Euphorbia georgiana M.H. Mayfield, sp. nov. (**Fig. 4**). Type: UNITED STATES. Georgia. Oglethorpe Co.: shallow soil, newly exposed area, Echols Mill granitic outcrop, 9.3 mi N, 45° east of Lexington, Piedmont Province, 13 May 1965, *D. Blake and F. Montgomery 136* (holotype: GA).

Similar to *E. austrotexana* M.H. Mayfield but with seeds that are larger and much more deeply pitted, and leaves that are oblanceolate; also similar to *E. commutata* Engelm., but the plants are smaller and have seed pits that are more crowded and confluent, and much deeper.

Glabrous annual herbs with taproots, 10–18 cm tall, stems erect, 1 to 3 from the base. Stem leaves alternate, sessile, ascending, blades 5–12 mm long, 3–5 mm wide at the widest point, oblanceolate to broadly oblanceolate, bases attenuate, apices rounded. Ray leaves 3, sessile, 9–11 mm long, 5–7 mm wide, rotund-obovate. Primary inflorescence rays 3, usually with 3 or 4 internodes from 1.5–2.5 cm long, upper nodes mostly dichasial, secondary rays 0 or 1 in the upper mainstem leaf axils. Raylet leaves free at the base, 3–6 mm long, length/width ratio 0.5–0.7, broadly deltate to subreniform, the bases truncate to emarginate, apices rounded to bluntly acuminate, blades oriented vertically, adaxial surface directed away from the plant axis. Cyathia: involucres funnelform, 1.0–1.1 mm high, 0.4–0.5 mm wide, on a stalk 0.3–0.5 mm long; cyathial glands lunate, 0.3–0.4 mm wide, horns 0.3–0.5 mm long, attenuate-filiform, the margins entire between the horns, involucral lobe apices attenuate, ciliate on the margins; staminate flowers 5 to 10. Pistil: styles 3, ca. 0.5 mm long, free to the base, bifid at the apices ⅓–½ of the length, the lobes ascending, capitate. Capsules 2.2–2.4 mm long, 3.2–3.4 mm wide, columellas 2.0–2.1 mm. Seeds 1.6–1.7 mm long, 1.4–1.6 mm wide, ovoid, rounded in cross-section, surface grayish on the ridges, nearly black within the pits, lustrous at maturity, with deep, variably sized, rounded, concave pits crowded and irregularly disposed over the entire surface; caruncles 0.6–0.7 mm wide, reniform-ovate, stipe concealed.

Euphorbia georgiana is apparently restricted to granitic outcrops and is probably endemic to the region of Georgia where these occur, but more focused study in the field is needed to adequately determine its distribution. The diminutive annual habit is quite distinct from the more robust biennial plants of *E. commutata*, the only species of the same section occurring in the area. These two species are also expected to be well-separated ecologically, as *E. commutata* grows in areas with basic soils derived from limestone. *Euphorbia georgiana* is generally most similar to *E. austrotexana* and *E. longicruris*, which also share its affinity for open gladey areas.

Etymology.—This species is named for the state of Georgia, in which it is endemic.

Additional specimen examined: **U.S.A. GEORGIA. Wilkes Co.:** N of Danburg, Porphyritic granite flatrock at end of dirt road trending NW from GA hwy 44, about 1.6 mi S of the Lincoln Co. line, 29 Apr 1980, *J.R. Allison 1410* (GA).

Euphorbia nesomii M.H. Mayfield, sp. nov. (**Fig. 5**). Type: MEXICO. Nuevo Leon. Municipio Higueras: Cuesta Mamulique, along old unused road through pass (N of the summit), N facing slope above road to 1 km W of Hwy. [85], with *Fraxinus greggii*, *Acacia*, *Yucca*, *Ungnadia specios*, dark soil in talus slopes at the base of the bluff, 26°12'10"N, 100°06'25"W (WGS84), elev. 600 m, common annuals along base of bluff, mostly ca. 5–8 cm tall, *M.H. Mayfield 1905, with C.J. Ferguson and A.L. Hempel* (holotype: MEXU; isotypes: ANSM, LSU, KSC, MICH, TEX).

Similar to *E. roemeriana* in having petiolate leaves and a multibranched spreading habit, but differing in having stem leaf blades that are rhombic-ovate to elliptic, raylet leaves being free to the base and subdeltate, and cyathial glands that are smaller and with longer horns.

Glabrous annual herbs with taproots, 8–18 cm tall, stems laxly ascending, basally decumbent, several from the base. Stem leaves alternate, petiolate, spreading, horizontal, petioles 3–6 mm long, blades 5–15 mm long, 3–7 mm wide at the widest point, blades subrhombic to rhombic-obovate, bases cuneate, apices obtuse to rounded. Ray leaves 3, sessile, 5–19 mm long, 4–7 mm wide, broadly elliptic to broadly oblanceolate. Primary inflorescence rays 3, usually with 2 to 4 internodes from 1.5–3.5 cm long, upper nodes mostly dichasial, secondary rays 0 to 2 in the upper mainstem leaf axils. Raylet leaves free at the base, 4–7 mm long, length/width ratio

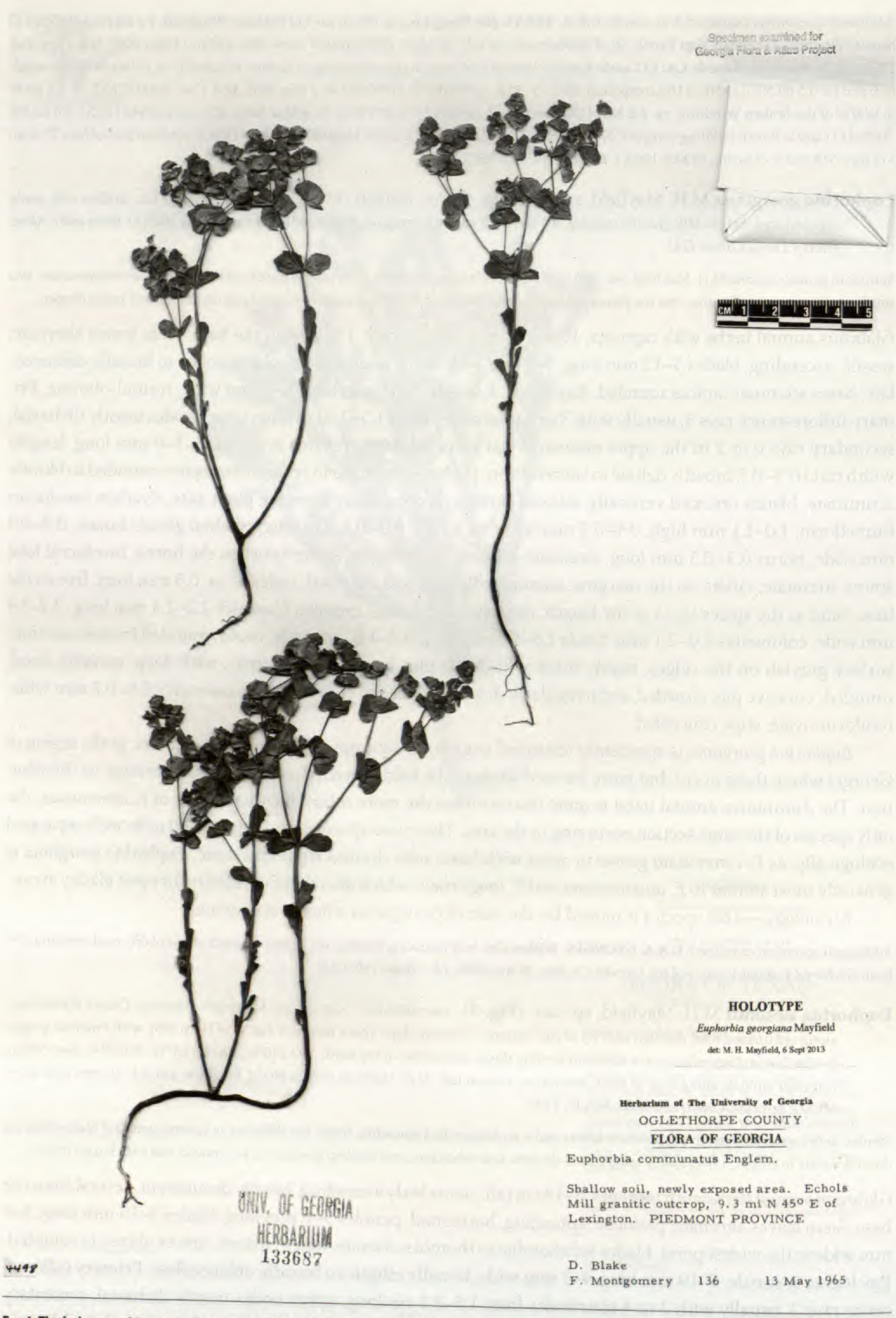

Fig. 4. The holotype of *Euphorbia georgiana*: *Blake & Montgomery 136* (GA).

FIG. 5. TEX isotype of *Euphorbia nesomii*: *Mayfield 1905*.

0.5–0.9, deltate to broadly deltate, the bases truncate, apices obtuse to abruptly acuminate, blades oriented nearly horizontally, the adaxial facing upwards. Cyathia: involucres broadly cup-shaped, 0.8–1.3 mm high, 0.6–0.10 mm wide, on a stalk 0.3–0.5 mm long; cyathial glands lunate, 0.9–1.1 mm wide, horns 0.5–0.7 mm long, attenuate-filiform, the margins entire between the horns, involucral lobe apices truncate and crenate on the margins; staminate flowers 10 to 15. Pistil: styles 3, ca. 1.5 mm long, connate at the base ca. 0.2 mm, bifid at the apices for ¼–⅓ of the length, the lobes divergent and ascending, capitate. Capsules 1.8–1.9 mm long, 2.3–2.5 mm wide, columellas 1.7–1.9 mm. Seeds 1.3–1.5 mm long, 0.6–0.7 mm wide, oblong-ovoid, rounded dorsally, slightly flat ventrally in cross-section, surface white to tan, darker in the depressions at maturity, with irregularly shaped broad concave depressions over the entire surface, ridges bordering pits rounded in relief; caruncles 0.4–0.5 mm wide, reniform-ovate, base stipe absent or inconspicuous.

Euphorbia nesomii is the first annual species of the section to be described from Mexico, where it occurs on relatively mesic limestone north-facing slopes in the mountains of northern Nuevo Leon in montane oak chaparral habitat under *Brahea spp., Cheiropetalum schiedeanum, Fraxinus greggii, Osmanthus sp.*, and *Ungnadia speciosa*. In addition to similarities in leaf and habit shared with *E. roemeriana*, it's seeds resemble those of *E. peplidion* in size and shape. Otherwise it has no clear shared features that might link it to any other of the other annual species. Like the last species described above, it has been poorly collected and warrants additional documentation and study.

Etymology.—This species is named for Dr. Guy L. Nesom, who first brought this plant to the author's attention when he collected it in 1993. In addition to being invaluable as a mentor during the early phase of the author's career, he has had an indelible impact on the field of Plant Taxonomy. The epithet honors his many contributions to botany and his generous spirit.

Additional specimens examined: **MEXICO. Nuevo Leon. Municipio Agualeguas:** Arroyo 5 km S of Ojo de Agua de Agualeguas, 400 mnm, 3 Feb 1983, *C.P. Cowan, with K.C. Nixon, M.C. Johnston, A.D. Zimmerman, and R. Allen 3773* (TEX). **Municipio Bustamante:** along switchbacks of road below the Grutas de Bustamante from opening of cave to ca. 4 road km below cave, 18 Mar 1994, *M.H. Mayfield with C.J. Ferguson and A.L. Hempel 1906* (LSU, MEXU, TEX). **Municipio Higueras:** Cuesta Mamulique, ca. 40 km S of Sabinas Hidalgo on Mex. Hwy 85, W side of "libre" highway, N-facing slope along base of roadcut of old discontinued road, ca. 520 m, 26 Mar 1993, *G. Nesom, B.L. Turner, J. Bain 7549* (MEXU, TEX). **Municipio de San Pedro:** in Chipinque 200 yards above gate, Monterrey, Feb 1961, *R.F. Smith M456* (TEX).

Euphorbia ouachitana M.H. Mayfield, sp. nov. (**Fig. 6**). Type: UNITED STATES. Oklahoma. Pushmataha Co.: 3.2 mi SE (130.0°) of Nashoba, slopes N of the mouth of Watson Creek (Little River), elev. 640 ft N 34.45261° W 95.17233°, 25 Apr 2002, *M.H. Mayfield 3551* (holotype: BRIT; isotypes: KANU, KSC, MICH, TEX, OKL, OKLA, UARK).

Similar to *E. commutata* and *E. tetrapora*, but differing in the seeds being consistently brown and somewhat lustrous (not whitened) at maturity, and in having deeper pits on the seeds.

Glabrous annual herbs with taproots, from 12–28(–32) cm tall, stems erect-ascending, often basally decumbent, 1 to a few stems from the base. Stem leaves alternate, sessile or briefly petiolate, laxly ascending to horizontal and spreading, petioles 0–3 mm long, blades 8–20 mm long, 3–9 mm wide at the widest point, broadly oblanceolate to subspatulate, bases attenuate, apices rounded. Ray leaves 3, sessile, 10–25 mm long, 15–32 mm wide, ovate-deltate to subrhombic-ovate. Primary inflorescence rays 3, usually with 3 or 4 internodes from 2.5–6.5 cm long, upper nodes dichasial, secondary rays 1 to 5 in the upper mainstem leaf axils. Raylet leaves connate to ca. 3 mm at the base, 6–18 mm long, length/width ratio 0.8–1.2, broadly deltate to subreniform, bases truncate to broadly obtuse, apices obtuse to bluntly acuminate, blades oriented obliquely, adaxial surface directed upwards and away from the plant axis. Cyathia: involucres funnelform, 1.3–1.6 mm high, 1.0–1.2 mm wide, on a stalk 0.4–0.7 mm long; cyathial glands oblong, 0.7–1.0 mm wide, horns 0.2–0.4 mm long, attenuate-filiform, the margins entire between the horns, involucral lobe apices rounded, short-ciliate on the margins; staminate flowers 15 to 20. Pistil: styles 3, ca. 0.8 mm long, free to the base, bifid at the apices for ⅓–½ of the length, lobes ascending, capitate. Capsules 2.6–2.7 mm long, 2.5–2.7 mm wide, columellas 2.0–2.1 mm long. Seeds 1.8–2.1 mm long, 1.1–1.2 mm wide, oblong-ovoid, rounded dorsally, slightly flat ventrally in cross-section, surface dark-brown, lustrous at maturity, with deep, rounded, uniformly spaced pits in vertical rows (3–4 in a vertical row per each ventral facet, 14–18 in 4 rows on the dorsal facet); caruncles 0.6–0.7 mm wide, reniform-ovate, base stipe present, umbonate.

Fig. 6. KSC isotype of *Euphorbia ouachitana*: *Mayfield 3551*.

Etymology.—This plant is named for the region in which it is best represented.

Chromosome Number.—$n = 13$ II (*Urbatsch et al. 981* [LL], Urbatsch et al. 1975).

Euphorbia ouachitana occurs in semi-open forests and woodlands, often in soils underlain by shale; but it also occurs in areas that are less sloped, and limited by thin soils on limestone. In many sites across the range, it is associated with the herbs *Packera obovata* and *Saxifraga virginiensis*.

The best-documented and expansive continuous part of the range for *E. ouachitana* is in the Ouachita Mountains from southeastern Oklahoma to the area around Hot Springs County, Arkansas. The type is from near the western margin of this range in Pushmataha County, Oklahoma. In Missouri, specimens are known only from the area of Roaring River State Park in Barry County. In Tennessee, its range is very possibly under-represented by collections. Five of the six known Tennessee populations are from north of the Cumberland River (Trousdale and Smith Counties) in the low, isolated hills situated on the edge of the Nashville Basin and eastern Highland Rim. A separate population further to the south in Rutherford County, Tennessee suggests that this species may eventually be found across a wider area of the Cedar Barrens in middle Tennessee. In Texas, the single population listed above was only recently discovered and reported as *E. commutata* by Singhurst et al. (2013).

Most of the range of *E. ouachitana* occupies the region between the southwestern-most populations of *E. commutata* and the northern-most populations of *E. tetrapora* in southeastern Oklahoma. Most previously collected specimens have been identified as *E. commutata*, reflecting a resemblance in habit. Yatskievych and Mayfield (2006) were the first to discuss its distinctiveness from *E. commutata*, referring to the populations in Barry County, Missouri. Among the more prominent features that distinguish these two species are life span and seed morphology (Fig. 2). *Euphorbia ouachitana* is a winter annual that completes most of its growth and reproduction during a short span in the spring from mid March to early May, whereas *E. commutata* is most often a biennial that grows vegetatively during its first year, then bolts to flowering in spring about the same time as *E. ouachitana*. At this time of year, the two species stand in stark morphological contrast: *E. commutata* is much taller, and bears numerous, closely spaced, long-petiolate elliptic leaves at the base of the stems, whereas, in *E. ouachitana*, the lowermost primary stem leaf blades are sessile and attenuate to the base. The lustrous reddish-brown seeds of *E. ouachitana* (Fig. 2), with deep pits in rows, are also easily distinguished from those of *E. commutata* and all similar species. *Euphorbia commutata* has darker brown seeds with more numerous pits that are not distributed in obvious rows. Lastly, if existing chromosome counts (see below) are correct and consistent across these taxa, *E. ouachitana* ($n = 13$) is cytologically distinct from *E. commutata* ($n = 14$).

Euphorbia ouachitana is also somewhat similar and may be confused with the annual *E. tetrapora*. It is distinct from the latter in larger overall plant size, and its substantially larger seeds with deeper, well-defined pits (Fig. 2). These two species also grow near each other in southeastern Oklahoma but *E. tetrapora* occurs on flat to gently sloping terrain with sandy soil in association with Post Oak-Blackjack Oak mixed woodlands.

The only species of section *Tithymalus* with which *E. ouachitana* is broadly sympatric is *E. longicruris*, a species that also occurs within the Ouachita Mountains of Oklahoma and Arkansas in shale slopes or glades without significant tree overstory (T. Witsell, Arkansas Natural Heritage Commission, pers. comm.). *Euphorbia ouachitana* occupies a more shaded woodland habitat with leaf litter and is distinct in its seeds (Fig. 2), and habit.

Additional specimens examined: **U.S.A. ARKANSAS. Garland Co.:** extreme N point of North Mt., in Hot Springs, 850 ft, 9 Apr 1934, *H.R. Gregg s.n.* (UARK); margins of Gulpha Cr., 25 Apr 1924, *E.J. Palmer 24551* (MO, UARK); Ouachita Mountains, along Mount Tabor Road, vicinity of 34.73248N, 93.31670W, 18 Apr 2008, *T. Witsell & J.C. Fraiser 14824* (ANHC); Cedar Fourche Recreation Area, vicinity of 34.66646N, 93.28357W, 6 May 2008, *T. Witsell & J. Krystofik 08-110* (ANHC, KSC). **Hot Springs Co.:** P.O. Magnet Cove, 500 ft, igneous intrusive area, rocky novaculite hills, 19 Mar 1938, *D. Demaree 16713* (SMU); P.O. Magnet Cove, 600 ft, igneous intrusive area, rocky Bluffs, 8 Apr 1939, *D. Demaree 18874* (MO, SMU); P.O. Malvern, 350 ft, Lake Catherine State Park, rocky open woods, 9 Apr 1955, *D. Demaree 36424* (MO, RSA); near the boundary of Lake Catherine State Park, T4S R18W sec4, NW, 14 Apr 1983, *F. Smith s.n.* (UARK); N of Land Camp Road, Ross Foundation land, area of 34-20-36.10N, 93-05-07.66W, 11 Apr 2008, *R. Bledsoe RF-08-6* "(ANHC)"; near 34-20-58.83N, 93-05-07.66W, 23 Apr 2008, *R. Bledsoe RF-08-21* (ANHC, KSC). Ouachita Mountains, N side of Camp Road, 34.33751N, 93.05338W, 23 Apr 2008, *T. Witsell & R. Bledsoe 08-23* (ANHC). **Howard Co.:** Baker Springs, 11 Apr 1909, *& 14 Apr 1909, J.H. Kellogg s.n.* (MO). **Logan Co.:** S side of Magazine Mtn, 30 Apr 1942, *D.M. Moore 420077* (UARK). **Montgomery Co.:** peninsula of Lake Ouachita, vicinity of 34.61820N, 93.49467W, 16 May 2005, *T. Whitsell & P. McKenzie 05-419* (ANHC); N of Lake Ouachita, on both sides of Forest Service Road 5140, vicinity of 34.65100N, 93.42377W, 6 May 2008, *T. Witsell & J. Krystofik 08-124* (ANHC); E side of the Iron Forks River, vicinity of 34.72089N, 93.40869W, 6 May

2008, *T. Witsell & J. Krystofik 08-120* (ANHC, KSC, UARK). **Polk Co:** ca 15 mi S of Mena in Caney Cr Wildlife Mgmt area along Cossatot River, 23 Apr 1983, *E. Sundell and J. Guldin 2999* (BRIT, NLU, UAM; adjacent to parking lot of a small park at the highway 246 bridge over the Cossatot River SE of Mena, T4S-R30W-sec 30, 18 May 1991, *L.E. Brown 15365* (SBSC); 7.7 mi ExNE (56.7°) of Wickes, Polk Co Rd 490, 1.4 mi S of AR hwy 246, elev. 950 ft, N 34.3626°, W 94.2245°, 11 Apr 2002, *M.H. Mayfield 3547* (KSC). **MISSOURI. Barry Co.:** N facing slope at Roaring River State Park, 21 Apr 1955, *J.W. Hardin 654* (US); N of hatchery past the picnic area, T22N, R27W, ne¼, sec 27, 18 May 1979, *K.L. Hornberger 207* (SMS); River Trail, T22N, R27W, se¼, sec 27, and ne¼, ne¼ sec. 34, 5 Jun 1979, *K.L. Hornberger 272* (SMS); Roaring River State Park. 500 ft N on river trail from State Rd F, 1040 ft, N 36.58197, W 93.83395, 30 Apr 2003, *M.H. Mayfield 3578* (KSC); Roaring River above cabins at State Park, elev. 1075 ft, N 36°35'53" W93°49'52", 28 Apr 2009, *M.H. Mayfield & D.V. Geltman 3789* (KSC); Piber Hollow, Roaring River State Park, N36.35.26 W93.50, 28 Apr 2001, *P.L. Redfearn, Jr. & M. Brunell 39969* (SMS); Piber Hollow, Roaring River State Park, alt. ca. 1050 ft, 9 May 1958, *P.L. Redfearn, Jr. & D. Houk 3558* (SMS); W facing limestone slope above the Roaring River, Roaring River State Park, 29 Apr 1960, *R. D. Houk & P.L. Redfearn 229* (SMS); South slope near edge of River Trail, R27W T22N sec 34, neQ, 14 Apr 1978, *S.L. Timme 36* (SMS), and 14 Apr 1978, *S.L. Timme 37* (SMS); ca. 6 mi S of Cassville, wooded trail above Roaring River, 30 Apr 1989, *W.W. Holland 6061* (KSP). **OKLAHOMA. Latimer Co.:** Buffalo Valley, ½ mi e and 1 ½ mi S of B.V. School [34.73190 -95.24563], 22 Apr 1966, *F.H. Means, Jr. 2437b* (OKL, OKLA); 4.5 mi N of Talihina along Bengal Road, 11 Apr 1966, *F.H. Means, Jr. 2421* (OKLA). **LeFlore Co.:** Camp Tom Hale Boy Scout Reservation, ca. 9 mi E and 1 mi S of Talihina, T3N, R23E, Sec 16; 15 327129 3845445, 12 Apr 2007, *B. Hoagland & A. Buthod CTH-455* (OKL); on N approach to Kiamichi Mtn. (Pushmataha Co), 18 Apr 1950, *J.M. Anderson 91* (OKL). **McCurtain Co.:** E of Broken Bow Lake and N of Turkey Mtn on E Otter Cr., T14S R26E, Sec. 2; 15S 357310 3789599, 7 Apr 2009, *A. Buthod & B. Hoagland AB-8014* (OKL); W of Broken Bow Lake at Glover R, nr crossing of Shell Rock Cr, T4S R23E, Sec 30; 15S 322027 3783505, 13 Apr 2009, *A. Buthod & B. Hoagland AB-8076* (OKL); W of Broken Bow Lake/hwy 259, NW of West High Peak, T4S R23E, Sec 5; 15S 332378 3789110, 9 Apr 2010, *A. Buthod & B. Hoagland AB-8798* (OKL); 16 mi n of Broken Bow, near Mt. Carter Lookout, 13 Apr 1941, *B. Paxton 115* (OKL); ca 5.9 mi due N of jct. of hwys 3 & 98, T4S R23E, Sec. 28; 15S 325038 3784194, 17 Apr 2008, *B. Hoagland & A. Buthod AB-7617* (OKL); Sweet Home Community Building, Church of Christ, 1.3 mi W of US 259, NW of Broken Bow, 8 Apr 1972, *B. Watters 396* (MO); just outside the entrance to BBSP and 3.5 mi E of the jct. of state hwy 21 and 21A, 2 Apr 1961, *C. Taylor 511* (OKL); Beaver Bend, 20 Apr 1941, *D.H. Dunn 33* (OKLA); Beavers Fork State Park, Broken Bow, 11 Apr 1936, *D. Demaree 12052* (OKL, SMU); near Horsehead Cr, 15 mi W of Broken Bow, [1 mi SE of Wright City], 15 Apr 1966, *E. Ensey 429* (KSC); above W shore of Mountain Fork River, BBSP, 10 Apr 1948, *G.T. Robbins 2894* (NY, OKL, UC); small stream E of Glover, 9 Apr 1949, *G.T. Robbins 3228* (NY, OKL, SMU, UC); BBSP, dry pine forest, 27 Apr 1952, *G.J. Goodman 5504* (OKL); Wilderness Area, N part, 19 May 1994, *P. Folley 827* (OKL); NE Broken Bow, mountain sides, 13 May 1930, *P. Sears 1492* (OKL); along W bank of lower Mountain Fork River, 0.5 mi S of low water Dam at south boundary of Beavers Bend State Park, T5S R25E, sec 14, 11 Apr 1981, *R.D. Thomas, T. Briley & N. Carroll 75418 & 2554* (NLU); Beaver Bend State Park, 16 mi N of Broken Bow, moist rich woods, 13 Apr 1941, *T. Johnson 42* (OKL); 13 mi N of Broken Bow, 16 Apr 1950, *U.T. Waterfall 9353* (ARIZ, OKLA); 7 mi N and 4 mi E of Broken Bow, wooded bottom along Mountain Fork, Beavers Bend SP, 26 Apr 1952, *U.T. Waterfall 10681* (OKLA, RSA, SMU); near hairpin curve, 15 mi N of Broken Bow [on road to BBSP], 19 Apr 1953, *U.T. Waterfall 11373* (OKL, OKLA, SMU, UC); edge of BB St. Park, NE of Broken Bow, 27 Apr 1957, *U.T. Waterfall 13036* (OKLA, RSA, SMU, UC) & *13037* (OKLA, SMU, UC, US); Beavers Bend State Park, 6 mi N and 4 mi E of Broken Bow, 18 Apr 1959, *V.L. Harms 192* (KANU); near boundary to Beavers Bend SP, 29 Apr 1979, *W.F. Mahler & J. Taylor 8488* (SMU); along roadside in Beaver Bend State Park, 22 Apr 1972, *L.E. Urbatsch 981* (LL); Leflore Co.: [sic], Beech Cr., 2 mi E of Beachton, 18 Apr 1979, *J.A. Howard & T. Antonio 483* (OKL); collected near NW corner of Beavers Bend SP, about 7 mi n and 3 mi e Broken Bow. N facing slope, 22 Apr 1978, *J. Taylor 25855* (BRIT, NLU); Cabin area of Beaver Bend State Park, elev. 450 ft, 34.13280, W 94.68151, 16 Apr 1999, *M.H. Mayfield & C.J. Ferguson 3109* (KSC); on HWY 259A, road to Beaver Bend State Park on high narrow ridge under power line by road, elev. 830 ft, N 34°07'18" W 94°41'57", 16 Apr 1999, *M.H. Mayfield & C.J. Ferguson 3108* (KSC, MICH); 16 mi N of Broken Bow, on W side of US 259, T4S R24E, sec. 10, T4S R24E, sec 10, 6 Jun 1978, *M. Fisher s.n.* (OKL); near Mt. Fork River on Morgan-Pollock Camp 5 mi N of Broken Bow, 10 Apr 1942, *M. Hopkins & J.R. Pollock 6259* (OKL); rocky slope, pine-oak forest, Beavers Bend St. Park, 20 Apr 1969, *N. Ehrlich 323* (KSC). **Pushmataha Co.:** 4.1 mi NW of Albion, on 1630, T2N R20E, Sec.2; 15S 300915 3838627, 3 Apr 2008, *A. Buthod & B. Hoagland AB-7404* (OKL); 3 mi E of Nashoba on Okla 144, 12 Apr 1968, *C.H. Perino & F. Duncan 79* (SMU); 4 mi E of Nashoba on Okla 144, 12 Apr 1968, *C.H. Perino & F. Duncan 79* (OKL); Kiamichi River, 0.5 mi S and 2 mi E of Tuskahoma, 5 Apr 1968, *F.H. Means, Jr. 3042* (OKLA); jct. of Little River and Watson Creek, 2 mi E, 2 S of Nashoba, 27 May 1968, *F.H. Means, Jr. 3209* (BRIT, OKLA); 3.1 mi SE (128.0°) of Nashoba, East of road on slopes above E side of Little River, elev. 640 ft, N 34.45526, W 95.17323, 11 Apr 2002, *M.H. Mayfield 3540* (KSC). **County unspecified:** Ouachita Mtns, 12 May 1937, *P.V. Beck 108* (OKL). **TENNESSEE. Rutherford Co.:** 1.5 air mi NW of Leanna, along W. Buckeye Bottom Rd, N of Sulfur Springs Rd, elev. 490 ft, N 35.95065, W 86.45351, 8 Apr 2008, *M.H. Mayfield & C.G. Mayfield 3748* (KSC); 11 Apr 2009, *M.H. Mayfield & S.R. White 3784* (KSC); 1.2 air mi NW of Leanna, along Joe Brown Road, SE corner of jct. with E Buckeye Bottom Rd, elev. 591 ft, N 35.95124, W 86.44586, 11 Apr 2009, *M.H. Mayfield & S.R. White 3781B* (KSC). **Smith Co.:** Petty Bluff, ca. 3.5 air mi NW of Carthage, steep SW facing slope above Cumberland R. and Hwy 25, just S of large Powerline R-O-W, elev. 610 ft, N 36.29195, W 85.99561, 30 Mar 2011, *M.H. Mayfield & C.G. Mayfield 3885* (KSC). **Trousdale Co.:** limestone bluffs of N bank of Cumberland River by TN 141, 0.5 mi S of Hartsville, 4 May 1973, *R. Kral 49808* (MO); N bank of Cumberland at 141, 8 May 1969, *K.E. Blum 3363* (TENN); 4.5 mi WNW (301.5°) of Hartsville, Snake Hollow Road south of Templow, ca. 0.7–0.8 road mi from jct. with TN 260 (Browning Branch Rd), elev. 725 ft, N 36.42511, W 86.23582, 15 Apr 2002, *M.H. Mayfield 3550* (KSC), 24 Apr 2004, *M.H. Mayfield 42404-1* (KSC), 8 Apr 2008, *M.H. Mayfield & C.G. Mayfield 3751* (KSC); 2.7 mi SE (134.2°) of Hartsville, Starlite Road, 0.4 road mi E of Lock 6 Rd, elev. 680 ft, N 36.3646, N 86.1319, 24 Apr 2004, *M.H. Mayfield 42404-3* (KSC); 4.0 mi WSW (251.0°) of Hartsville, Oldham Road, ca. 0.3 road mi E of Carey Road jct., elev 700 ft, N 36.37295, W 86.2341, 24 Apr 2004, *M.H. Mayfield 42404-2* (KSC), 8 Apr 2008, *M.H. Mayfield & C.G. Mayfield 3753* (KSC). **TEXAS. Red River Co.:** 3.5 mi S of the jct. of Tex. Hwy 195 and [Red River] County Rd. 2245 … Little Pine Creek, 20 Apr 2013, *J.R. Singhurst & H. Peters 19327* (BAYLU, KSC; Singhurst et al. 2013).

CHROMOSOME NUMBERS FOR NEW WORLD SECTION *TITHYMALUS*

Chromosome study was undertaken where possible for taxa of *Euphorbia* sect. *Tithymalus*. Developing buds were field-collected in a solution of four parts chloroform, three parts 95% ethanol and one part glacial acetic acid; with later transfer to 70% ethanol. Following the technique of B.L. Turner described in Jones & Luchsinger (1986), anthers were dissected out, stained with acetocarmine solution, squashed and examined for meiotic figures. A new count of n = 13II was made for *E. longicruris* (*Mayfield 2174* [TEX], Lampasas Co., Texas); and imperfect meiotic figures were observed for *E. austrotexana* var. *austotexana* (n = ca. 12–13II, *Mayfield & Ferguson 2160* [TEX], Atascosa Co., Texas), *E. peplidion* (n = ca. 14II, *Mayfield & Ferguson 2161* [TEX], Atascosa Co., Texas), and *E. roemeriana* (n = ca. 14II, *Mayfield 2158*). One previously published count for "*E. tetrapora*" of n = 13II corresponds to *E. ouachitana* (Urbatsch et al. 1975). A chromosome number of $2n$ = 28 was reported by Perry (1943) for the common eastern annual/biennial *E. commutata*. Among North American perennials, a chromosome number of n = 14II was reported for *E. brachycera* Engelm. from Otero Co., New Mexico (Urbatsch et al. 1975), whereas Ward (1984) reported n = 13 for the perennial *E. chamaesula* Boiss. Numbers for three additional perennial taxa from the western U.S.A. are documented by herbarium specimen annotations as having n = 13 chromosomes: *E. lurida* Engelm. (Garfield Co., UT, *Windham 96-035* [MO]), *E. sp. nov. aff. lurida* (Clark County, Nevada, *Windham 98-239* [MO]), and *E. yaquiana* Tidestr. (Gila Co., Arizona, *Windham 94-24* [MO]). *Euphorbia peplus*, a species closely related to the North American section *Tithymalus* (Riina et al. 2013), has a haploid number of 8 (numerous counts in the literature; see Tropicos, http://www.tropicos.org/Name/12800171?tab=chromosomecounts). Together, these data suggest that the North American species may have undergone significant chromosomal evolution prior to their diversification, and that aneuploidy may have played a role in speciation. It is therefore likely that further investigations into the chromosome numbers may provide insight into evolution of the New World members of *E.* section *Tithymalus*.

KEY TO THE NON-PERENNIAL SPECIES OF *EUPHORBIA* SECTION *TITHYMALUS* IN THE NEW WORLD (AND SIMILAR NON-NATIVE TAXA)

1. Plants biennial; seeds ≥ 1.8 mm long; primary ray bracts about as wide as long or wider, generally suborbicular to broadly ovate; plants occurring outside of Texas.
  2. Seeds rotundly ovoid, strongly pitted, with distinct, round depressions on a generally flat surface; plants of the eastern United States and southern Ontario, Canada (northeastern Oklahoma north to Wisconsin, east to Pennsylvania, and south to Florida and Mississippi) ____ **E. commutata**
  2. Seeds oblong-ellipsoid, weakly dimpled, with shallow, irregularly shaped depressions bordered by weak reticulating ridges, surface nowhere flat; plants of the western United States (southern California to northwestern Oregon, also local in southern Colorado and northern New Mexico ____ **E. crenulata**
1. Plants annual; seeds ***mostly*** ≤ 1.7 mm long; primary ray bracts ***usually*** longer than wide; plants often occurring in Texas and elsewhere.
  3. Stem leaves generally erect-ascending at maturity, if lax, the blades less than 3 mm wide at the widest point.
    4. Raylet leaves at least 1.5 × longer than wide, the apices acute.
      5. Seeds rotund; stems mostly strict, erect or virgate ____ **E. austrotexana** var. **carrii**
      5. Seeds oblong; stems laxly ascending.
        6. Seeds with troughlike and rounded pits, the surface not pimpled ____ **E. peplidion**
        6. Seeds without pits, the surface pimpled ____ **E. exigua**
    4. Raylet leaves about as long as wide, or wider than long.
      7. Leaves linear to linear-oblanceolate ____ **E. austrotexana** var. **austrotexana**
      7. Leaves spatulate to oblanceolate.
        8. Seeds uniformly covered with deep, well-defined rounded pits on both surfaces ____ **E. longicruris**
        8. Seeds with 4 (or 5) shallow ventral pits, and 4 rows of indistinct pits on the dorsal surface ____ **E. tetrapora**
  3. Stem leaves generally divergent or lax at maturity, and over 4 mm wide at the widest point.
    9. Stem leaves with petioles or elongated petiole-like bases.
      10. Raylet leaves apically obtuse, subdeltate; plants 8–18 cm tall ____ **E. nesomii**
      10. Raylet leaves apically rotund, subreniform to scarcely deltate; plants 15–35 cm tall.
        11. Capsules with longitudinal wings along the ridges; seeds 1.3–1.5 mm long, bearing two longitudinal sulcae on the ventral facet ____ **E. peplus**
        11. Capsules without longitudinal wings along the ridges; seeds 1.8–2.0 mm long, smooth to pitted, but not sulcate on the ventral facet.
          12. Seeds smooth (10×), lacking reticulating ridges ____ **E. helleri**
          12. Seeds not smooth (10×), with reticulating ridges ____ **E. roemeriana**

9. Stem leaves sessile, or attenuate to a brief, petiole-like base.
   13. Seeds with few well-separated shallow pits in vertical rows; plants occurring on sandy soils within the Gulf Coastal Plain (Louisiana, Oklahoma, and Texas) **E. tetrapora**
   13. Seeds with crowded, sharply defined, deep pits; plants only occurring on granite outcrops within the Piedmont Province of Georgia **E. georgiana**

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BOOK REVIEW

Werner Kunz. 2012. **Do Species Exist? Principles of Taxonomic Classification.** (ISBN-13: 978-3-527-33207-6, hbk.). Wiley-Blackwell, 111 River Street, Hoboken, New Jersey 07030-5774, U.S.A. (**Orders:** www.wiley.com, 1-877-762-2974). $99.95, 280 pp., 6 ¾" × 9 ½".

Do Species Exist by Werner Kunz is in many ways Western science writ small; it is an attempt to impose an orderly understanding on an inherently unruly natural world. The order in which Werner Kunz devoutly believes is that not only do species exist, but there exists a rational means for distinguishing one from another. Each system has had its difficulties, from Plato with his Forms that under-lie all of the observable world, to Linnaeus with his system of nomenclature that, he believed, would reveal the mind of God at the moment of creation. In the modern era, the problem of classification has been both illuminated and complicated by Darwin's insights into the origin of species. No longer are groups of organisms perfect and unchanging. Rather, we are seeing them at a moment in time—not at peace in some final form, but rather in the very midst of a continual process of change.

It is exactly this understanding of evolution and its impact on taxonomy that informs Kunz' s manuscript. He rightly points out that the question is made all the more difficult by the simple fact that everyone knows what a species is, even though no one has been able to offer a succinct and useful definition. Certain elements may be widely agreed on, such as the consensus that any useful definition of a species must contain the stipulation of common descent. That is, that all organisms bearing a particular taxonomic designation must be more closely related to each other than to any outside group.

It is in just such endeavors that Kunz is at his strongest. The first portion of the book is a painstakingly detailed examination of just what is agreed on in modern taxonomy, followed by a dissection of the various systems that have been employed by taxonomists in classifying the natural world. If Kunz finds few novel insights in this survey, he does at least offer a very well organized critique. This is, after all, well-tread territory. Kunz even notes that Darwin, in his *On the Origin of Species*, had pointed out the difficulty of defining that central term: species.

If *Do Species Exist* were merely a summary of definitions and the shortcomings of taxonomic systems, it would better serve as a chapter in a textbook, albeit one laden with poorly chosen illustrations clumsily composed in Photoshop. Kunz, however, goes one step further, and ventures into advocacy for phylogenetics as the only practicable way of conducting taxonomy. This advocacy, however, appears only in the penultimate chapter (?) and is given a curiously cursory treatment, considering the meticulous critiques of the preceding chapters. It is almost as though Kunz, having shown the inadequacies of competing taxonomic systems, presents the "phylocode" as the last option standing.

The shortfalls in Kunz argument are three-fold. The first and most obvious is that he presumes that currently extant systems of classifications are the set from which we must choose. To quote Sherlock Holmes, "…[w]hen you have eliminated the impossible, whatever remains, however improbable, must be the truth." While other systems may have logical or practical inconsistencies, it does not follow that phylocode, devoid of "archaic Linnaean terminology", is a more appropriate system of classification. It may be the most logically consistent method we currently know of, but that does not mean that is the system which best reflects the world-as-it-is.

The second and more serious flaw in Kunz's argument for the phylocode approach is that his proposal simply does not pass the "smell test" for working scientists. In other words, phylogenetic methods may produce mathematically and logically satisfying results, but the results are frequently of little utility outside the trees which they adorn. The species concept, after all, is based on the observations of field scientists cataloging morphological differences among the specimens they observe in the natural world. Morphology is at best a dim

(continued on p. 658)

HACKELIA TAYLORI (BORAGINACEAE),
A NEW SPECIES FROM NORTH CENTRAL WASHINGTON STATE (U.S.A.)

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ABSTRACT

Hackelia taylori (Boraginaceae), here named, is known from only three populations. Plants are found growing on very steep, sandy/gravelly talus slopes within the Alpine Lakes Wilderness, Okanogan-Wenatchee National Forest, Washington, USA. The species differs from similar *Hackelia* spp. by having relatively small blue flowers (mean limb width 1.3 cm) with small fornices (mean 0.81 mm), short stature (mean 14.9 cm), short but wide lower cauline leaves (mean length 1.5 cm, width 0.7 cm), and small nutlets (mean length 2.6 mm). Additionally, *H. taylori* is distinguished from the most closely related *H. venusta* by markedly different habitats, different flower color and other morphological characters (cauline leaves, nutlet size, floral structures) which are generally smaller, and lack of seeds produced in controlled crosses.

RESUMEN

Hackelia taylori (Boraginaceae), nombrada aquí, es conocida sólo en tres poblaciones. Las plantas se encuentran creciendo en taludes muy empinados, de arena / grava en las laderas del desierto Alpine Lakes, Okanogan-Wenatchee bosques nacionales. La especie difiere de otras *Hackelia* similares por tener flores pequeñas azules con fondos de saco pequeño, baja estatura, hojas caulinares cortas pero anchas, y núculas pequeñas. Además, *H. taylori* se distingue de la más estrechamente relacionada con *H. venusta* por sus hábitats muy diferentes, ausencia de formas intermedias naturales y la falta de semillas producidas en los cruzamientos controlados.

Hackelia Opiz. includes 45 species of perennial plants distributed within Northern Temperate region, Central and South America combined (Mabberley 1987). In North America, 28 species are recognized, comprising 34 taxa, many of which are narrow endemics (Gentry & Carr 1976). Species of *Hackelia* can be found in a wide range of habitats, including sagebrush steppe, steep talus slopes, moist rock crevices, open deciduous forests, and *Abies* or *Pinus* forests; and the distribution of many species are narrowly restricted based on habitat, geography, or elevation (Carr 1974; Gentry & Carr 1976). Gentry and Carr (1976) completed a comprehensive study of *Hackelia* and clarified taxonomic relationships of the species and subspecies in North America. However, the taxonomic status of *H. venusta* (Piper) St. John has remained in question (Gamon 1988) and recently has been the focus of taxonomic research (Harrod et al. 1999; Hipkins et al. 2003).

Hackelia venusta, as originally described, includes a white-flowered form found at one low elevation site (488 m) 9.6 km northwest of Leavenworth, Washington, and a blue-flowered form found at four currently known high elevation (ca. 2050 m) alpine locations about 18 km northwest and southwest of Leavenworth, Washington (Carr 1974; Gentry & Carr 1976; Hitchcock et al. 1959) (Fig. 1). The two forms were shown to be distinct from each other based on morphological traits (Harrod et al. 1999). However, enzyme band pattern analyses did not provide evidence for taxonomic separation of the two color forms (Hipkins et al. 2003). Although at first this may seem to be a dilemma, taxonomy is often the result of synthesis across many lines of evidence, some of which may fail to support the taxonomic hypothesis (Grant 1992; Winston 1999; Hipkins et

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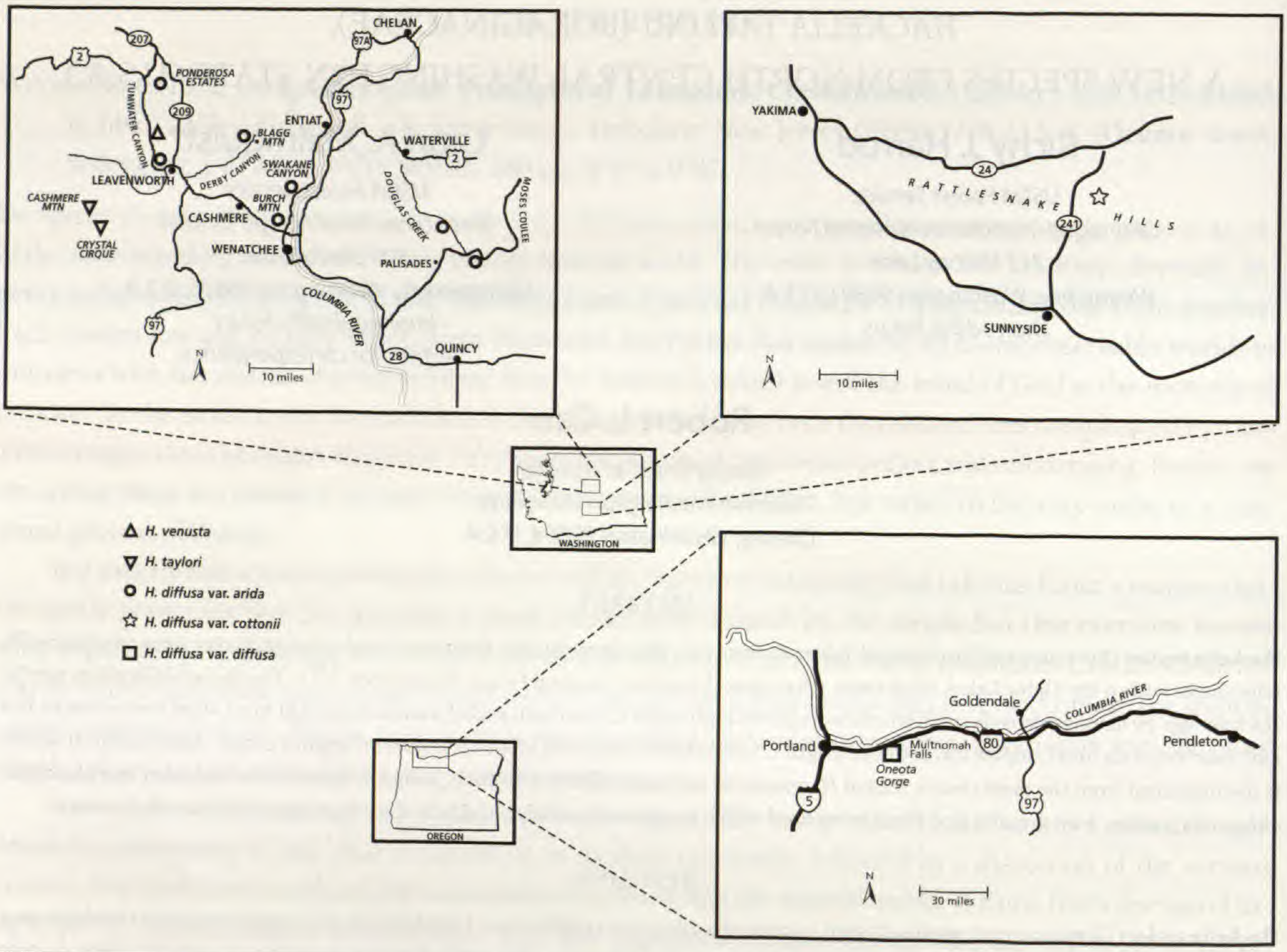

Fig. 1. Locations of the populations of *Hackelia* in Washington State, USA, examined in this study.

al. 2003). Taxonomic entities are defined on a combination of morphology, genotypic data (e.g., isozymes), ecology, reproductive isolation, and geographic distribution. There are compelling reasons to consider the two flower color forms to be separate species based on morphological and ecological distinctions.

Here we provide a technical description for the alpine form at the rank of species, here named *Hackelia taylori*. Although *H. taylori* was shown to be morphologically distinct from *H. venusta* in our previous work (Harrod et al. 1999), we wanted to evaluate the morphological distinctiveness of *H. taylori* with respect to other varieties of *H. diffusa* (Doug. ex Lehmann) Johnston which we did not study previously, but which were included in the enzyme work of Hipkins et al. (2003).

MATERIALS AND METHODS

Study Sites

Data were collected from 10 populations used by Harrod et al. (1999) with 2 additional *H. diffusa* populations that we felt may have some affinity to *H. taylori* (Fig. 1) based on suggestions in Gentry and Carr (1976). The collection site for these two additional sites are: 1) *H. diffusa* var. *cottonii* (Piper) Carr, located on private land in the Rattlesnake Hills (RH), 25 km north of Sunnyside, WA 150 m elevation; and 2) *H. diffusa* var. *diffusa*, located at Oneota Gorge (OG) near Multnomah Falls, 50 km east of Portland, OR 75 m elevation.

Voucher specimens deposited at the Wenatchee River Ranger District herbarium:

Hackelia diffusa var. ***diffusa*.** **OREGON. Multnomah Co.:** Oneota Gorge, 52.9 km E of Portland, Harrod 406.

Hackelia diffusa var. ***arida*.** **WASHINGTON. Chelan Co.:** Tumwater Canyon, 1.6 km W of Leavenworth, 28 May 1996, *Malmquist 01*; 1.6 km W of Leavenworth, 05 Jun 1996, *Malmquist 02*; Derby Canyon, 11.3 km SE of Leavenworth, 09 May 1996, *Malmquist 05*; 11.3 km SE of Leavenworth, 09 May 1996, *Malmquist 06*; 11.3 km SE of Leavenworth, 09 May 1996, *Malmquist 07*; Ponderosa Estates, 17.7 km N of Leavenworth,

20 May 1997, *Malmquist 08*. **Douglas Co.:** Moses Coulee, 24.0 km N of Quincy, 08 May 1996, *Malmquist 03*; 24.0 km N of Quincy, 08 May 1996, *Malmquist 04*.

Hackelia diffusa var. ***cottonii*****. Yakima Co.:** Rattlesnake Hills, 25 km N of Sunnyside, 24 Jun 1997, *Malmquist 09*; 25 km N of Sunnyside, 24 Jun 1997, *Malmquist 10*.

Hackelia venusta**. Chelan Co.:** Tumwater Canyon, 9.6 km W of Leavenworth, 25 Jun 1991, *Harrod 293*.

Hackelia taylori**. Chelan Co.:** Cashmere Mountain, 19.0 km SW of Leavenworth, 4 Aug 1996, *Kuhlmann 01*; 16.0 km SW of Leavenworth, 21 Aug 1997, *Benson 01*.

Voucher specimens deposited at WTU:

Hackelia venusta**. Chelan Co.:** Tumwater Canyon, 9.6 km W of Leavenworth, 31 Jun 1998, *Harrod 410*.

Hackelia taylori**. Chelan Co.:** Crystal Creek, 19.0 km SW of Leavenworth, 29 Jul 1991, *Harrod 238*; Cashmere Mountain, 16.0 km SW of Leavenworth, 21 Aug 1997, *Benson 02*.

Morphological Measurements and Statistical Analyses

We followed the same methods and used most of the same data (individual plants from original 10 populations with missing morphological data were dropped from analysis) as described in Harrod et al. (1999). Nineteen morphological characters from three categories (vegetative, floral, and fruit) were scored for statistical analysis and an additional 11 descriptive characters (e.g., leaf shape, leaf surface, color) were recorded (Table 1). These data were collected from 25 randomly selected individuals from each population except the Cashmere Mountain population, which consisted of data from 14 individuals, and Crystal Cirque with only 10 individuals. Both principal components and discriminant analyses were performed on the quantitative morphological data using SPSS 16.0 (SPSS, Chicago, Illinois). Principal components analysis (PCA) was used to evaluate the natural groupings among each sampling unit or operational taxonomic unit (population). Discriminant analysis was used to establish the non-arbitrariness of group assignments. This analysis places each case (plant) within the group (population) with which it shares discriminating characters (Anderson and Taylor 1983). The analysis is biased in that it positions cases within the ordination based on discriminating characters to achieve maximum separation of the defined groups. A plot of the cases based on the first two discriminating functions can assist in visualizing distinction among groups and species. The data for these analyses involved a 237 × 19 character matrix.

Descriptive characters were not subjected to statistical analyses but were used to further detail morphological characteristics of the new taxon.

RESULTS

The addition of *H. diffusa* var. *cottonii* and *H. diffusa* var. *diffusa* in both the principal components and discriminant analyses lead to tighter groupings of cases as compared to the results of Harrod et al. (1999). Of the 19 components that accounted for all the variance in the PCA, the first three accounted for 65.1% (32.5%, 20.7%, and 11.9%, respectively). Characters highly correlated with the first component were lower cauline leaf width and length, upper cauline leaf width, and radical leaf width (Table 2). *Hackelia diffusa* var. *cottonii* and *H. diffusa* var. *diffusa* separated from other taxa along the first component (Fig. 2A). Plant height, radical leaf petiole length, radical leaf length, and upper cauline leaf length were characters highly correlated with the second component (Table 2). Along this second component, *H. taylori* (CC and CM) separated from the *H. diffusa* var. *arida* populations forming a distinct group that was somewhat overlapping with the *H. venusta* population (TC) (Fig. 2A). The third component separated *H. venusta* from *H. taylori* and characters highly correlated with the third component were upper cauline leaf length, limb width, fornice protuberance, and calyx length (Table 2, Fig. 2B).

The discriminant analysis showed *H. taylori* was more clearly distinct from *H. venusta* and almost the entire *H. diffusa* complex (Fig. 3). The first two discriminant functions accounted for 81.8% of the ability to distinguish among groups (51.2% and 30.6%, respectively). Total predictability that a case from a certain population was correctly classified to that population was 95.8%. Individual cases (plants) had high predicted group membership with the sampled population from which they were sampled. *Hackelia taylori* plants from CM were 100% correctly classified and those from CC were 95.8% correctly classified, with 4.2% classifying with

TABLE 1. Morphological characters used in the taximetric analysis of *H. taylori* and other *Hackelia* species. All measurements in mm unless otherwise noted.

Vegetative	Floral	Fruit
Plant height (dm)	Pedicel length	Nutlet shape (descriptive)
Radial leaf length	Calyx length	Nutlet surface (descriptive)
Radial leaf width	Calyx shape (descriptive)	Nutlet length
Radial leaf petiole length	Limb width	Number of intramarginal prickles
Radial leaf shape (descriptive)	Corolla color (descriptive)	Flange width
Radial leaf surface (descriptive)	Anther length	Distinct prickle length
Lower cauline leaf length	Fornice color (descriptive)	Fraction connate
Lower cauline leaf width	Fornice appendage height	
Lower cauline leaf shape (descriptive)	Fornice protuberance length	
Lower cauline leaf surface (descriptive)		
Upper cauline leaf length		
Upper cauline leaf width		
Upper cauline leaf shape (descriptive)		
Upper cauline leaf surface (descriptive)		

TABLE 2. Variables used in the PCA and loadings on the first three principal components. The asterisk reflects the top four values for each axis and identifies the variables contributing the most.

Variables	Loadings Axis 1	Axis 2	Axis 3
Lower cauline leaf width	0.904*	-0.029	-0.039
Lower cauline leaf length	0.805*	0.431	-0.019
Upper cauline leaf width	0.800*	-0.140	0.106
Radial leaf width	0.773*	-0.067	0.155
Fraction connate (fruit)	-0.741	-0.304	0.407
Flange width (fruit)	-0.737	-0.251	0.309
Distinct prickle length (fruit)	0.632	0.198	-0.159
Plant height	0.205	0.836*	-0.092
Radial leaf petiole length	0.254	0.793*	-0.178
Radial leaf length	0.228	0.732*	-0.283
Upper cauline leaf length	-0.382	0.717*	0.169
Limb width (floral)	0.028	-0.442	0.800*
Fornice protuberance (fruit)	-0.143	-0.326	0.745*
Calyx length (floral)	0.034	-0.439	0.743*
Fornice appendage (fruit)	0.120	-0.644	0.670*
Pedicel length (floral)	-0.360	0.144	0.646
Nutlet length (fruit)	-0.047	0.329	0.525
# of intramarginal prickles (fruit)	0.231	0.155	0.506
Anther length (floral)	0.008	-0.016	-0.008

CM. The most important characters for achieving separation in this analysis are displayed in Table 3. In the first discriminant function, flange width, calyx length, fornice appendage, and limb width were important discriminating characters. Additionally, fornice protuberance, upper cauline leaf length, lower cauline leaf width, and nutlet length were important discriminating characters in functions 2 and 3 (Table 3).

TAXONOMIC TREATMENT

Hackelia taylori Harrod, Malmquist & Carr, sp. nov. (**Fig. 3**). TYPE: UNITED STATES. WASHINGTON: Chelan Co.: Upper levels of Crystal Creek cirque, ca. 150 m S of Crystal Lake on steep SSE facing slope, ca. 47°28.30'N, 120°48.00'W, 29 Jul 1991, *R.J. Harrod 238* (HOLOTYPE: WTU!; ISOTYPES: WTU!).

Hackelia venustae (Piper) St. John aspectibus mophologiae ac habitudo similis sed distinctus habitatione locorum editiorum, statura breviore (1–2 dm vs. 2–4 dm), corollis caeruleis (vs. praecipue albas) limbis multo angustioribus (10–15 mm latis vs. 18–22 mm) et fornicibus minoribus (appendix 0.8–1.0 mm alta vs. 1.0–1.4 mm; protuberatio 0.6–1.0 mm longa vs. 1.2–1.8 mm).

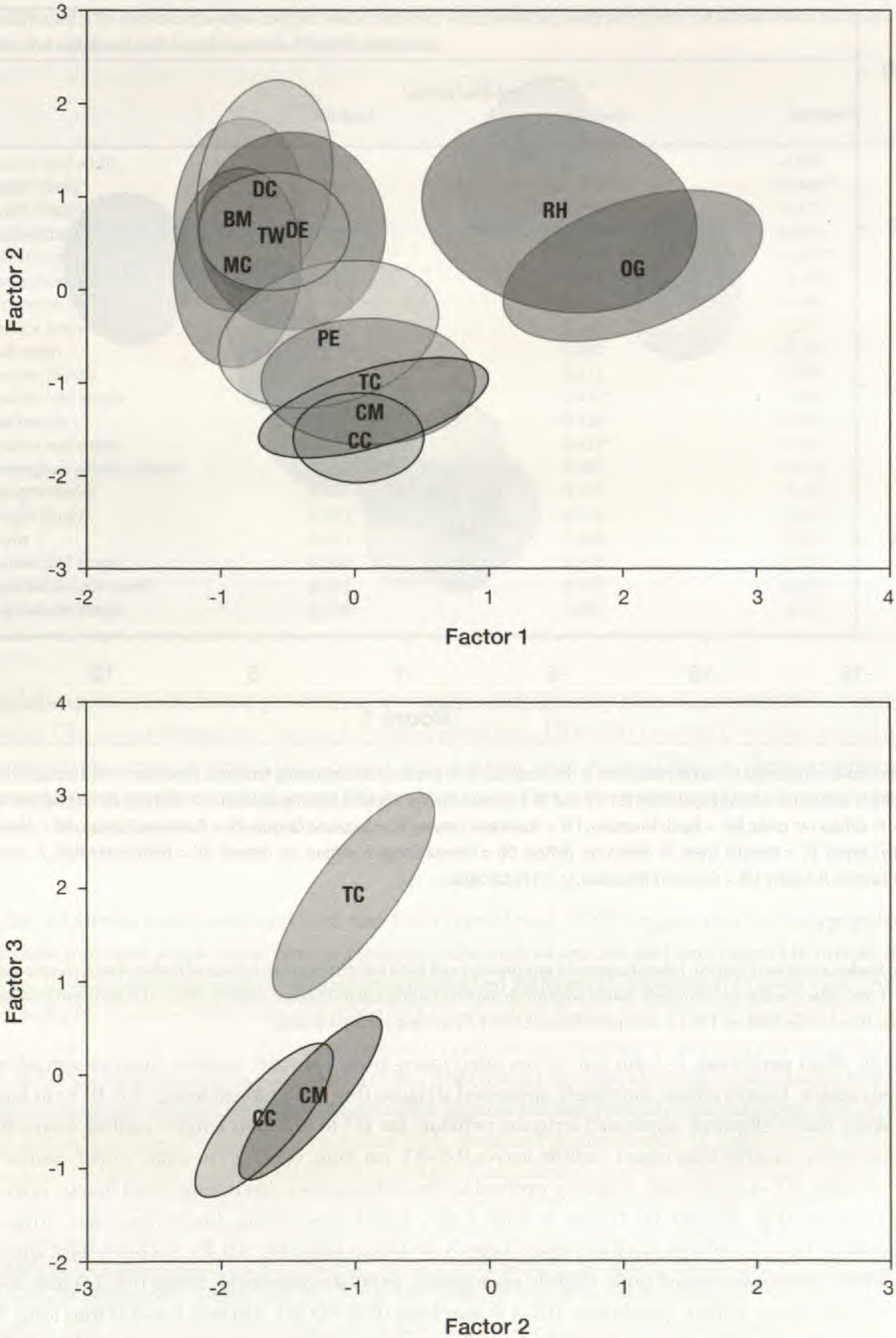

Fig. 2. A. Ordination of populations of *Hackelia* examined in this study based on scores of principal components 1 and 2. The first two components accounted for 53.2% of the total variance, 32.5% and 20.7%, respectively. *Hackelia taylori* populations (CC and CM) are highlighted with heavy black line. **B.** Ordination of populations of *Hackelia venusta* and *H. taylori* examined in this study based on scores of principal components 2 and 3. The third component accounted for an additional 11.9% of the variance for a total of 65.1% for the first three. *H. diffusa* var. *arida*: BM = Burch Mountain, TW = Tumwater Canyon, SC = Swakane Canyon, PE = Ponderosa Estates, MC = Moses Coulee, DE = Derby Canyon, DC = Douglas Creek. *H. diffusa* var. *diffusa*: OG = Oneota Gorge. *H. diffusa* var. *cottonii*: RH = Rattlesnake Hills. *H. venusta*: TC = Tumwater Canyon. *H. taylori*: CM = Cashmere Mountain, CC = Crystal Creek.

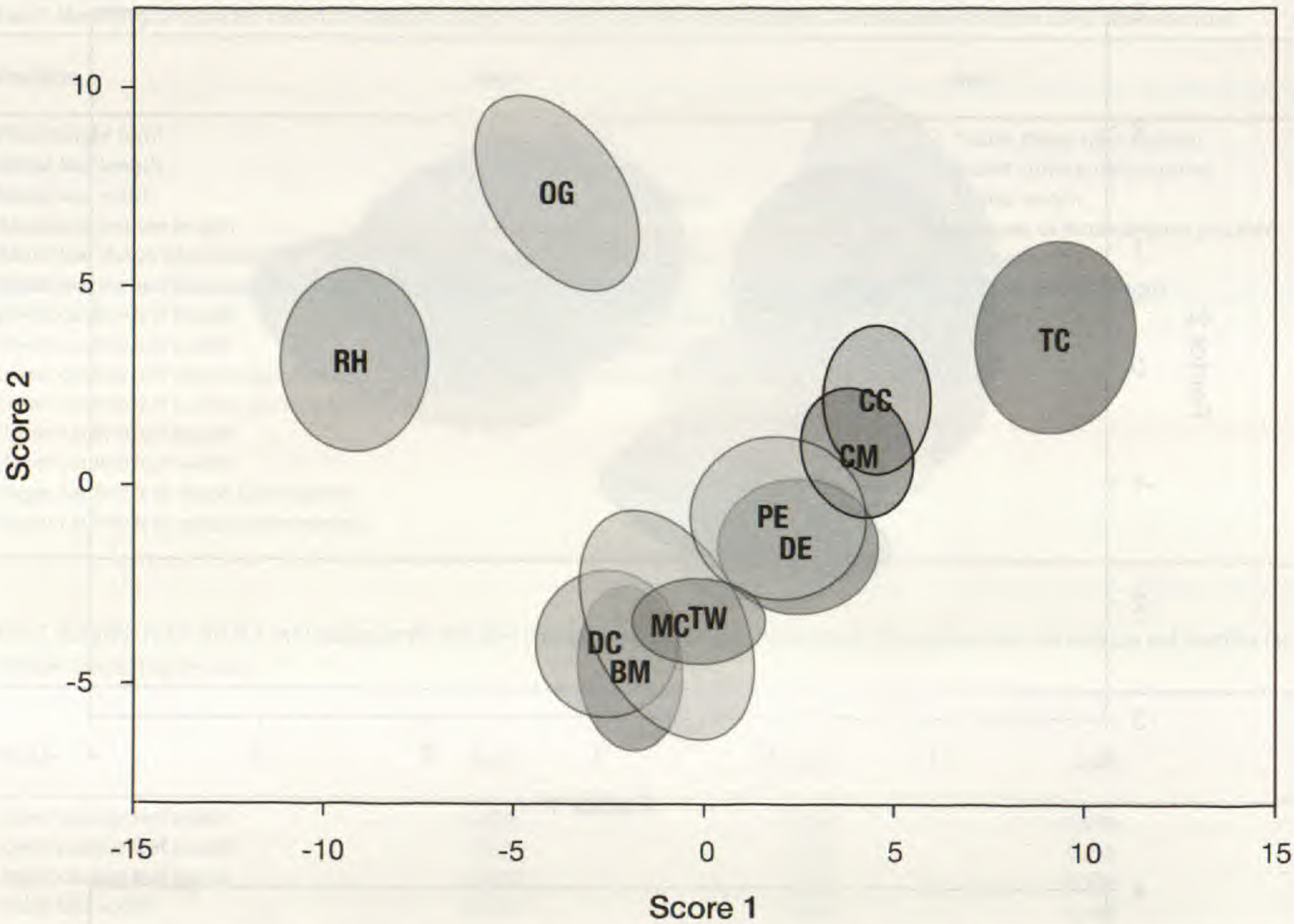

Fig. 3. Ordination of populations of *Hackelia* examined in this study based on two most discriminating functions. Functions 1 and 2 accounted for 81.8 % of the ability to distinguish among populations (51.2% and 30.6%, respectively). *Hackelia taylori* populations (CC and CM) are highlighted with heavy black line. *H. diffusa* var. *arida*: BM = Burch Mountain, TW = Tumwater Canyon, SC = Swakane Canyon, PE = Ponderosa Estates, MC = Moses Coulee, DE = Derby Canyon, DC = Douglas Creek. *H. diffusa* var. *diffusa*: OG = Oneota Gorge. *H. diffusa* var. *cottonii*: RH = Rattlesnake Hills. *H. venusta*: TC = Tumwater Canyon. *H. taylori*: CM = Cashmere Mountain, CC = Crystal Creek.

Similar to *Hackelia venusta* (Piper) St. John in aspects of morphology and habit but distinct in its habitat of higher places; shorter stature (1–2 dm vs. 2–4 dm); blue corollas (vs. primarily white) with much narrower limbs (10.0–15.0 mm wide vs. 18.0–22.0 mm) and smaller fornices (appendage 0.8–1.0 mm high vs. 1.0–1.4 mm; protuberance 0.6–1.0 mm long vs. 1.2–1.8 mm).

Moderately short perennial, 1–2 dm tall; stems often many from a slender taproot, erect or spreading from branched caudex. Leaves ciliate, antrorsely appressed strigose (Fig. 4A); radical leaves 3.7–10.4 cm long, 0.8–2.9 cm wide, linear-elliptical, appressed strigose, petiolate for 1/3 to 1/2 their length; cauline leaves linear to linear-lanceolate, sessile; lowermost cauline leaves 0.6–3.1 cm long, 0.4–1.2 cm wide; upper cauline leaves 1.9–5.3 cm long, 0.5–1.3 cm wide, reducing upward to the inflorescence, becoming small bracts. Pedicel 2.3–5.1 mm in flower (Fig. 3B) and 5.0-7.0 mm in fruit. Calyx length 2.4–3.4 mm, linear-lanceolate, strigose. Corolla limb blue, 1.0–1.7 cm wide with five lobes, lobes 3.0-5.0 mm long (Fig. 4D, F). Fornices with appendages showy, white, sometimes tinged pink, slightly emarginate, papillate-pubescent, rising 0.8–1.0 mm above the throat; protuberances yellow, pandurate, 0.6–1.0 mm long (Fig. 4D, E). Anthers 0.8–1.0 mm long. Nutlets 1.8–3.6 mm long, lanceolate-ovate; dorsal surface verrucose-hispidulous, intramarginal prickles 7–13; marginal prickles connate for up to 1/2 their length, forming a flange 1.2–2.4 mm wide around the nutlet; distinct prickle length 0.7–1.4 mm, a long prickle alternating with one or two shorter ones (Fig. 4C).

Etymology.—The epithet "*taylori*" honors Dr. Ronald J. Taylor, who taught botany at Western Washington University, Bellingham, Washington. Dr. Taylor co-authored the first status report for *H. venusta* in 1979 and was actively involved in native plant conservation in the Pacific Northwest for nearly 40 years.

TABLE 3. Variables used in the discriminant analysis and their relative usefulness in discrimination among populations. The asterisk reflects the top four values for each function that contributed most toward separation of *Hackelia* populations.

Variables	Function Coefficients Function 1	Function 2	Function 3
Lower cauline leaf width	0.904*	-0.029	-0.039
Flange width (fruit)	0.502*	-0.415*	-0.460*
Calyx length (floral)	0.410*	0.094	-0.277
Fornice appendage (fruit)	0.404*	0.419*	-0.023
Limb width (floral)	0.271*	0.211	0.635*
Fornice protuberance (fruit)	0.245	-0.074	0.425*
Fraction connate (fruit)	0.163	-0.099	-0.198
Upper cauline leaf width	0.042	0.298	-0.277
Radial leaf width	0.014	0.082	-0.279
Anther length (floral)	0.007	0.014	-0.002
Upper cauline leaf length	-0.015	-0.446*	0.409
Radial leaf length	-0.046	-0.138	-0.025
Lower cauline leaf width	-0.063	0.427*	-0.121
# of intramarginal prickles (fruit)	-0.064	0.067	-0.014
Pedicel length (floral)	-0.088	-0.110	0.140
Nutlet length (fruit)	-0.192	-0.118	0.457*
Plant height	-0.231	-0.146	0.254
Lower cauline leaf length	-0.264	0.210	0.154
Distinct prickle length (fruit)	-0.323	0.332	-0.230
Radial leaf petiole length	-0.358	0.021	0.115

Hackelia taylori can be found growing on very steep, sandy/gravelly talus slopes within the Alpine Lakes Wilderness, Okanogan-Wenatchee National Forest at elevations, 1800-2300 meters. Only four populations are known: within the upper reaches of the Crystal Creek drainage, near Aasgard Pass, on the east slopes of Cashmere Mountain, and on the south slopes of Big Jim Mountain. Plants flower in late July and early August, producing seed within about two weeks of the initial flower.

DISCUSSION

Data collected for this study combined with data from Harrod et al. (1999) suggest that the high populations of *H. venusta* do represent a new taxon here recognized at the rank of species, and here named *H. taylori*. Reasons for species level recognition include distinct morphological differences, particularly flower color, markedly different habitats (Gamon 1988), absence of natural intermediate forms, lack of seeds produced in controlled crosses (Harrod, unpubl. data), and consistency with previous morphometric taxonomy in the genus (Gentry & Carr 1976). As in the current study, Harrod et al. (1999) found the high elevations populations of *H. venusta* were morphologically distinct from the low elevation population and sympatric populations of *H. diffusa* var. *arida*. In addition to flower color, they found that high elevations populations of *H. venusta* were distinct from the low elevation population with consistently smaller floral measurements, shorter stature, and wider and shorter radical and lower cauline leaves. Findings from the current study were similar in that *H. taylori* is not only morphological distinct from *H. venusta* (*sensu stricto*) but also from the complex of *H. diffusa*. Based on both principal components and discriminant function ordinations, *H. taylori* did not show morphological affinities with *H. diffusa* var. *diffusa* nor *H. diffusa* var. *cottonii*. These species are nearly four times taller, have larger leaves, and slightly larger fruits than *H. taylori*, and are always white flowered rather than blue.

The similar genetic identities described by Hipkins et al. (2003) suggest that *H. venusta* and *H. taylori* are closely related and may have diverged recently. The morphometric analysis may support recent divergence as well. Although forming distinct groups, *H. taylori* populations did slightly overlap the *H. venusta* population in the principal components ordination space when only the first two components are considered. The populations become clearly distinct with the third principal component, in which important floral (limb width and calyx length) and fruit (fornice protuberance and appendage) characters lead to separation. In addition, *H.*

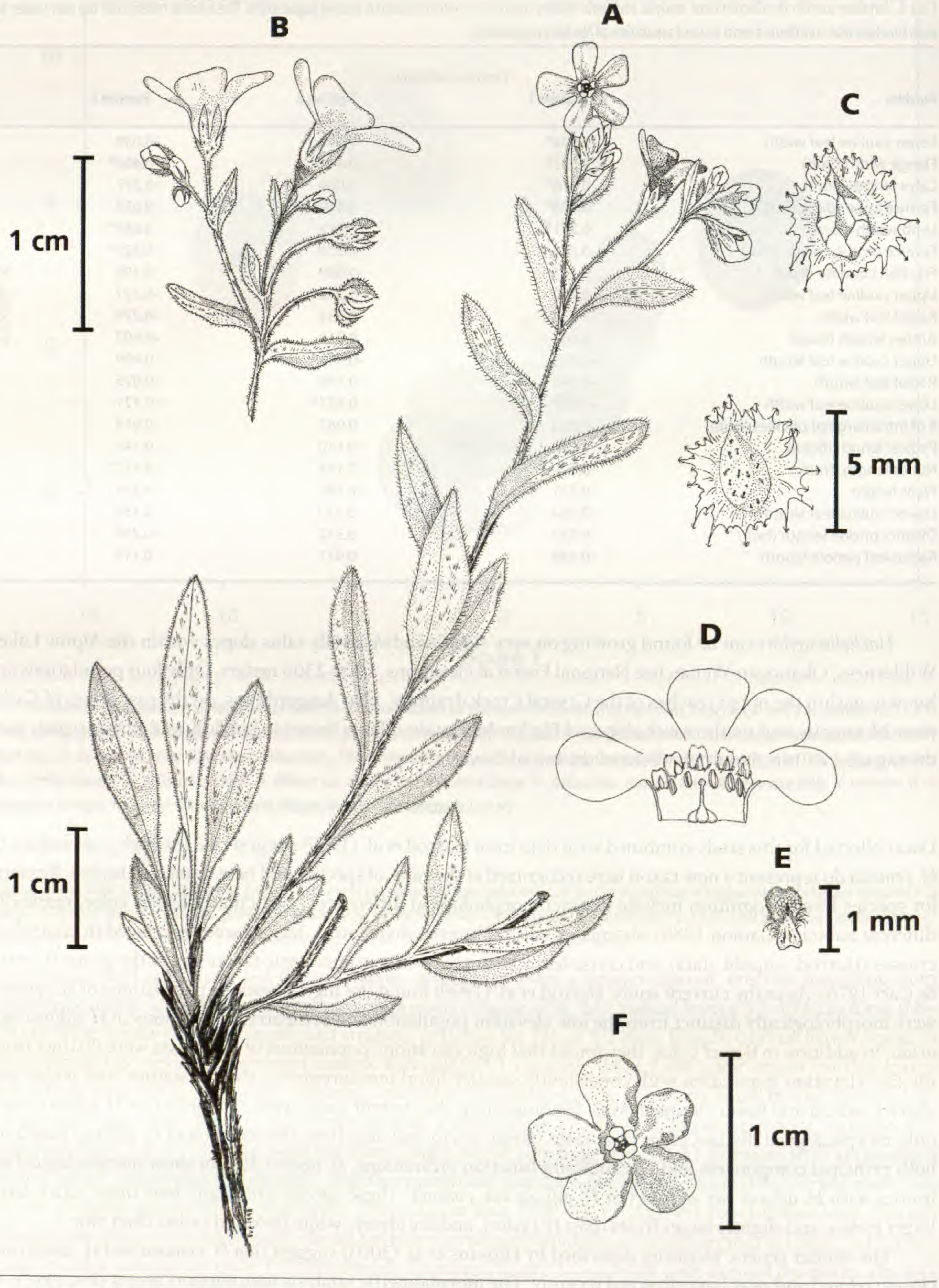

Fig. 4. ***Hackelia taylori*. A.** Plant with flowers and leaves; **B.** Inflorescence; **C.** Nutlets, upper view is ventral view, lower is dorsal view; **D.** Longitudinal section view of the corolla; **E.** Fornice; **F.** Top view of corolla. Bar = 1 cm in A, B, D, and F, and 1 mm in C and E.

taylori flowers are always blue and *H. venusta* flowers are white but sometimes tinged blue suggesting perhaps they share some genes for color.

Like *H. venusta,* this new species would benefit from well-developed conservation strategies. Populations are at risk from loss due to stochastic events, such as rock slides, which were the cause of the loss of most of one known population of *H. taylori*. Conservation strategies might include long-term seed banking so that populations could be re-established in the event of a stochastic loss.

ACKNOWLEDGMENTS

We would like to thank John Gamon, Loyal Mehrhoff, and Kali Robson for their work early-on suggesting a new species description. Dottie Knecht, Mark Ellis, Cedar Drake, Ellen Kuhlmann, and Shelly Benson provided field assistance. Brandy Reed assisted with data analysis. We thank Pam Camp for help in locating populations of *H. diffusa* var. *arida* on BLM land. We thank Guy Nesom for providing the Latin description. This project was cooperatively funded by the USDA Forest Service, USDI Fish and Wildlife Service, and the Washington Natural Heritage Program. Figures 1 and 2 were developed by Dan O'Connor, Okanogan-Wenatchee National Forest. Illustrations of *H. taylori* in Figure 3 were drawn by Eve Ponder. We also thank two anonymous reviewers for detailed and constructive reviews.

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BOOK REVIEW

WERNER KUNZ. 2012. **Do Species Exist? Principles of Taxonomic Classification.** (ISBN-13: 978-3-527-33207-6, hbk.). Wiley-Blackwell, 111 River Street, Hoboken, New Jersey 07030-5774, U.S.A. (**Orders:** www.wiley.com, 1-877-762-2974). $99.95, 280 pp., 6 ¾" × 9 ½".

(continued from p. 648)

mirror in which to observe the fundamental differences among living things, resting as it does at the apex of several shifting layers of DNA, epigenetics and environmentally- influenced gene expression patterns. And yet, it is at the level of morphology, of phenotype, that influenced gene expression patterns. And yet, it is at the level of morphology, of phenotype, that organisms meet the outside world in which their fitness is measured by nature, red in tooth and claw. Morphology, in other words, is not an abstraction or obstruction to understanding "true" relationships, but rather an essential part of classification.

The lure of the phylocode lies in the promise of certainty and objectivity. A DNA sequence is an objectively observable truth, and the processes by which one sequence may mutate into another are reasonably well described. The process of phylogenetics is not at issue, but rather the meaningfulness of the results of that process.

The meaningfulness criterion is simply that the genes and sequences currently used for phylogeny have at best a tenuous connection to the fitness of an organism or even its habitat or ecological role. In other words, phylogenetics can measure the distance between two organisms, but cannot speculate on the significance of that distance.

As a case in point from the world of microbiology, consider the humble *Escherichia coli* bacterium. Measured by the standards of molecular taxonomists, *E. coli* strain H7:O157 and *E. coli* strain K12 are identical. When mixed with hamburger meat, however, the H7:O157 strain can cause kidney failure and death while K12 will pass through the digestive tract without a trace. It is not the molecular taxonomists who have elucidated these strains that have >99.9% identity in 16S rDNA sequence, but pathologists treating lethal food poisoning outbreaks. In other words, those most concerned with life-as-it-is have identified the critical cell-surface antigens overlooked by molecular taxonomists.

The issue with phylogenetics as presented by Kunz, in an admittedly brief treatment, is not that it fails at mathematical consistency or clearly discernible taxa. It does. It is the relevance of those distinctions that is in question and that he does not address.

The final substantive criticism of Kunz book lies with its questionable premise: that there exists a logically consistent means of classifying the elements of the natural world. In this quest one can hear the echoes of Plato's insistence on Forms. Rather than a perfect Form of an individual species, however, we have moved to the perfect Form of taxonomy. We are not quite able to see it, but we know it exists. Each new generation of mathematical algorithm refines the closest fit between our approximations and the perfect reality.

And yet, it may be that taxonomy is an inherently messy process. Life, after all, is inherently messy. There are as many lineages stretching back to the Last Universal Common Ancestor (LUCA) as there are organisms currently living. Each path is necessarily unique, and it may be that drawing lines around any subset is an exercise in wishful thinking. Just because the confusion of life's diversity is unsettling to our pattern-loving minds does not necessitate that a deep pattern exists.

Rather it may be that the best system of classification mirrors life itself in its messy *ad hoc* clumpings. Genetic comparisons would certainly be a part of that system, but genetic distance may not be the only distinction of merit—and especially so when the sequences in question have little relevance to fitness.—*Brian Witte, PhD, Botanical Research Institute of Texas Research Associate, Adjunct Professor of Biology at Collin College, and freelance writer.*

UNA NUEVA ESPECIE DE *SOBRALIA* (ORCHIDACEAE) DE EL SALVADOR

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RESUMEN

Se describe e ilustra con fotografías a **Sobralia paulancalmoi** J. Linares, una especie nueva y hasta ahora endémica de El Salvador. Esta especie probablemente esté cercanamente relacionada con *Sobralia macra* de la cual se distingue por ser de hábito completamente terrestre o litofítico en lugar de epifito, por sus tallos florales con solo 4–5(–8) hojas y por las dimensiones y coloración de las flores.

ABSTRACT

Sobralia paulancalmoi, a new species native and endemic to El Salvador, is described and accompanied with photographs. This species is probably related to *Sobralia macra*, from which it differs in having a terrestrial or lithophytic growth habit instead of epiphytic, for its stems with only 4–5(–8) leaves and for the size and color of the flowers.

El Salvador cuenta con al menos cinco especies y una variedad de *Sobralia* Ruiz & Pav. (Hamer 1974, 1981). La circunscripción específica no presenta mayores problemas, pues las especies son claramente diferentes entre sí. Sin embargo, el último tratamiento de este género para el país fue el realizado por Hamer (1974, 1981) y ha habido cambios sustanciales en el entendimiento del género desde entonces. Entre las especies tratadas en las Orquídeas de El Salvador aparece una, cuya descripción, distribución y ecología no concuerdan con las delimitaciones actuales de dicha entidad; se trata de la especie referida como *Sobralia macra* Schltr. en la obra precitada y llamada así en todos los tratamientos y trabajos subsiguientes relacionados con la flora de El Salvador. Durante mucho tiempo, el nombre *S. macra* fue asignado sin objeciones a las plantas provenientes de la parte suroccidental de El Salvador, que no encajaban ni en *Sobralia macrantha* Lindl. (y especies afines) ni en *Sobralia decora* Bateman, este último nombre asignado a las plantas de las zonas más bajas. Sin embargo, los conocedores y estudiosos del género, como el Dr. Robert L. Dressler, identificaron los ejemplares de herbario depositados en herbarios de Estados Unidos como pertenecientes a *Sobralia leucoxantha* Rchb.f., basándose en el color mucho más pálido de las flores, citado en las etiquetas como morado, violeta o rosado pálido. Al revisar el material y la literatura referida a *Sobralia macra*, es notorio que esta especie tiene flores casi completamente blancas y crece en lugares mucho más húmedos, ecológicamente distintos y se encuentra bastante alejado de las localidades de El Salvador. Después de una revisión detallada de las posibles especies relacionadas presentes en el país o en países cercanos, como *Sobralia blancoi* Dressler & Pupulin, *Sobralia leucoxantha*, *Sobralia macra*, *Sobralia macrantha*, *Sobralia pendula* Dressler & Pupulin y *Sobralia rogersiana* Christenson y otras del complejo *Sobralia leucoxantha* o cercanamente relacionadas (Christenson 2007; Dressler 2012; Dressler y Pupulin 2008, 2012) se concluye que las plantas encontradas en El Salvador corresponden a una especie no descrita que se propone a continuación como un taxón nuevo para la ciencia.

Sobralia paulancalmoi J. Linares, sp. nov. (**Figs. 1–6**). Tipo: EL SALVADOR. San Salvador: Municipio San Salvador, Loc. Cultivada en casa de Paul Ancalmo, norponiente de la ciudad de San Salvador, 13°41'56"N, 89°13'53"W, alt. 785 m, 16 enero 2013, *Paul Ancalmo s.n.* (holotipo: ITIC!).

Sobraliae macrae Schltr. similis sed habitu terrestri vel lithophytico, caulibus floriferis paucifoliis, plantis inordinatis, colore florum roseo, maculaque hastata in labello differt.

Plantas cespitosas con 3–7(–9) tallos, las plantas adultas de aspecto desaliñado, con 1–2 tallos floríferos. Tallos delgados en relación con su longitud, por lo que se vuelven ligeramente arqueados (semierectos), cubiertos de

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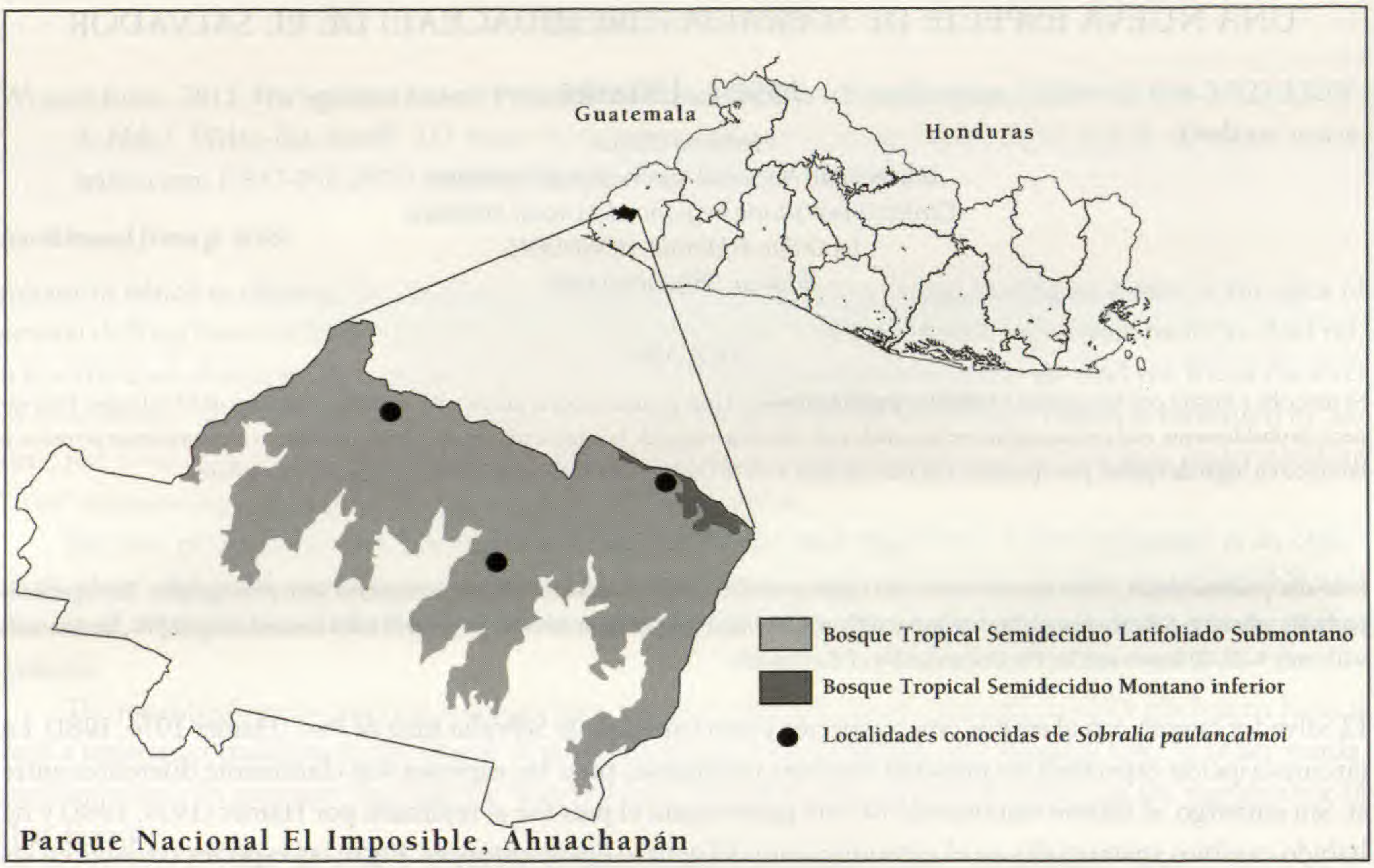

Fig. 1. Distribución geográfica y ecológica de *Sobralia paulancalmoi* J. Linares.

vainas secas muy adheridas al tallo. Tallos (53–)100–120 × 0.3–0.4 cm, revestidos de vainas parduscas y fibrosas, algo manchadas pero glabras, produciendo muchas hojas, pero prontamente defoliados y con sólo 4–5 hojas en las porciones apicales y a veces con sólo 2 hojas, secando negruzcas o pardo oscuro y con hasta 10–12 entrenudos defoliados. Hojas de 18–21 × 3–4 cm, lanceoladas, plisadas, glabras, verdes concoloras, coriáceas, algo convexas, ocasionalmente con manchas diminutas, especialmente en la parte inferior y en las vainas, las cuales están firmemente adheridas al tallo. Inflorescencias de una sola flor, terminales, con vainas glabras de 2 × 3 cm, largamente acuminadas, verdes. Las flores duran usualmente dos días, cerrándose al final del primer día y abriendo nuevamente al día siguiente. Flores de 9.5 cm en su parte más ancha y de 8 cm en su parte más alta y de ca. 10 cm de su parte más larga. Sépalo dorsal 6.5–7.7 × 1.5–1.8 cm; sépalos laterales (6.5–)6.9–8 × 1.7–2 cm (incluyendo un mucrón en el ápice de 1 mm y una porción basal unida de 1.5 cm); los sépalos son de color rosado pálido a violeta, con la parte distal de un tono más intenso y con el lado adaxial más claro, a veces casi blanco. Pétalos 6.2–7.3 × 2.0–2.4 cm, rosados, ligeramente más intenso hacia el ápice y del mismo tono en ambas caras; en general, los pétalos presentan una coloración ligeramente más intensa que los sépalos. Labelo 8.2–8.8 × 4.1–4.5 cm, con una porción tubular de 1.4 cm de ancho (en la parte adaxial) y 2 cm de alto (visto de perfil), nectario 0.3 cm de diámetro, ubicado en la base del tubo, labelo de silueta infundibuliforme y asimétrica, hinchada en la parte inferior, semejándose ligeramente a la silueta estilizada del vientre de una ballena; el labelo se rompe con facilidad al intentar aplanarlo, deformándose el tubo; la parte distal no tan profundamente bilobada, sino más o menos emarginada y mucronada, expandida, flabeliforme, con bordes revolutos. La porción central hacia el ápice con una mancha alabardada, amarilla, con la parte más ancha hacia el ápice del labelo; esta mancha es muy característica, pero su forma alabardada sólo es claramente visible al expandir el labelo; en la garganta se pueden distinguir 3 líneas bien definidas de color amarillo intenso a café amarillento y 1 línea más pequeña a cada lado de las 3 líneas centrales; estas líneas laterales son más tenues que las centrales y se distinguen sólo dentro la mácula alabardada; porción apical 85 × 50 mm, bordes y ápices poco crenulado-ondulados, la porción basal engrosada, formando un tubo que envuelve a la columna, tubo de contorno

ventral, es decir, visto de lado, es claramente convexo; base inferior rosada, la garganta rosado pálido a casi blanca, ápice rosado violeta. Columna de 4.7–4.8 × 0.6–0.7 cm en su parte más ancha y de 0.5 cm en su parte más alta, claviforme, basalmente curvada y con dos cornículos falcados y triangulares en su porción distal, blanquecina en sus partes basal y media y con un ligero tinte rosado a púrpura en los cornículos, especialmente en la parte adaxial. Las flores tienen una fragancia fuerte y algo desagradable, parecida a la del insecto del Orden Blattodea conocido como cucaracha común, con reminiscencias del olor de las brácteas de la inflorescencia de banano y trazas levemente dulces. Cápsula no vista.

Nombre común.—flor de un día.

Estado de Conservación.—de acuerdo con los criterios de la Lista Roja de Especies Amenazadas (UICN 2012) y según las observaciones del autor de las únicas son subpoblaciones conocidas en la área de distribución de la especie, la categoría sería Vulnerable, VU A1(d).

Distribución, hábitat y fenología.—Conocida sólo de la parte suroccidental de El Salvador (Fig. 1), en la vertiente norte del macizo montañoso de El Imposible, en el ecosistema bosque tropical semideciduo latifoliado submontano, bien drenado, secundario y/o intervenido (WICE 2012) donde crece terrestre en riscos rocosos azotados por el viento, en lugares con acumulación de humus. Entre la flora observada en la localidad tenemos arbustos pequeños de *Dalbergia calycina* Benth. (Leguminosae), *Rapanea* sp. (Myrsinaceae), *Schoepfia vacciniiflora* Planch. ex Hemsl. (Olacaceae), *Rondeletia laniflora* Benth. (Rubiaceae), *Berberis johnstonii* Standl. & Steyerm. (Berberidaceae) y hierbas como *Lasiacis* sp. (Poaceae), *Zeugites americanus* var. *mexicanus* (Kunth) McVaugh (Poaceae), *Perezia* sp. (Asteraceae). Entre las orquídeas encontradas en esas localidades se encuentran *Corymborkis forcipigera* (Rchb.f. & Warsz.) L.O. Williams, *Epidendrum ciliare* L., *Epidendrum trianthum* Schltr., *Maxillariella variabilis* (Bateman ex Lindl.) M.A. Blanco & Carnevali, *Oncidium sotoanum* subsp. *papalosmum* R. Jiménez, *Platystele ovalifolia* (F. Focke) Garay & Dunst., *Polystachia foliosa* (Hook.) Rchb.f. y *Stanhopea saccata* Bateman

Especímenes adicionales examinados: **EL SALVADOR. Ahuachapán:** Tacuba, Cumbre El Caballo, behind Tacuba. On slope, Flowers May 4, rainy season, red-violet, 1240 m, 13°52'00"N y 89°58'00"W, 16 Dec 1968, *F. Hamer 283* (MO [Ilustrado en Hamer 1974]); San Francisco Menéndez, Cima del Cerro El León, orquídea terrestre de 53 cm; tallo delgado, fibroso; hojas simples de hasta 19 cm de largo y 2.7 cm de ancho; flores moradas; frutos verdes, 1100 m, 13°49'00"N y 89°56'00"W, 4 Jun 1997, *E. Sandoval ES – 1603* (LAGU!, MO); San Francisco Menéndez, El Imposible, San Benito al N del mirador al C. León, 13°49'00"N y 89°56'00"W 31 Mar 1992, *Eliberto A. Sandoval & F. Chinchilla P. 343* (LAGU!, MO).

Floración en enero (en cultivo en San Salvador). Aparentemente no es de floración gregaria, pues florece varias veces al año en forma irregular, sin florecer todas las plantas de la especie al mismo tiempo. Fructificación desconocida.

Eponimia.—Es un honor dedicar esta especie a Paul Ancalmo (1948–), destacado y acucioso cultivador de las orquídeas de El Salvador, especialmente interesado en la conservación y cultivo del género *Sobralia*, tan descuidado y poco entendido en el país. Gracias a los esfuerzos de Paul, ahora podemos decir que entendemos mucho mejor las especies salvadoreñas de este género.

Discusión.—Los rasgos más característicos de esta especie son su hábito terrestre (o raramente litofítico), el crecimiento vegetativo con tallos casi sin hojas en el hábitat natural (Fig. 2), llegándose a observar ejemplares casi completamente defoliados o con sólo dos hojas; la ausencia de crecimientos laterales (hijos o keikis); las hojas usualmente de menos de 4 cm de ancho, versus hojas de más de 4 cm de ancho en *Sobralia macra*; además, las hojas de S. macra son elíptico-ovadas y acuminadas y la de *S. paulancalmoi* son angostasmente elípticas y largamente acuminadas (Fig. 3); las partes florales de *S. paulancalmoi* son más grandes que las de *S. macra*, llegando el sépalo dorsal a medir hasta 6.7 cm de largo contra solo 6.2 cm en *S. macra;* los sépalos laterales pueden llegar a medir 8 cm de largo mientras que en *S. macra* no pasan de 6.5 cm; por otra parte el labelo en *S. paulancalmoi* puede llegar a medir hasta 8.8 cm y en *S. macra* no pasa de 6.8 cm de largo; el hábito de las flores de abrir dos días seguidos, el olor fuerte y la coloración distinta de las flores, las cuales son rosado pálido a algo cerúleas y el olor fuerte de las flores, especialmente a tempranas horas de la mañana.

Las flores que duran, al menos en cultivo, más de un día, aunadas a la morfología, la ubican claramente en el complejo de *Sobralia leucoxantha* (Dressler y Pupulin 2008, 2012), lo que hizo que fuera confundida con esa

Fig. 2. Planta de *Sobralia paulancalmoi*, mostrando el aspecto desaliñado y algunos tallos con pocas hojas y ligeramente arqueados. Crédito fotográfico: Paul Ancalmo.

especie, conocida sólo de Costa Rica y Panamá. Dentro de este complejo, se separa fácilmente de *S. leucoxantha* por sus flores sin las dos manchas características de color morado oscuro en la parte basal interior del labelo, el color lila en lugar de amarillento o crema de *S. leucoxantha,* De *S. blancoi*, especie con la cual probablemente esté relacionada, se puede separar fácilmente por la coloración y por la ausencia de la mancha como "máscara" de color púrpura oscuro que esa especie presenta en el labelo. Entre otros rasgos distintivos que separan a *S. paulancalmoi* de las otras especies del complejo *S. leucoxantha* tenemos la mancha alabardada, o como flor de lis, con la parte más ancha hacia el ápice del labelo, de color amarillo ocre o hasta un tono ligeramente parduzco (Fig. 4).

Con respecto a las restantes especies de *Sobralia* existentes en El Salvador se puede separar de *S. macrantha* y *S. rogersiana*, por las flores de apariencia mucho más pequeñas debido a que no abren tanto como las de esas especies. Las flores son parecidas en forma y tamaño a las de *S. macrantha* y *S. rogersiana* pero con un color mucho más claro, con el labelo no tan profundamente bilobado sino más o menos emarginado y mucronado (Figs. 5, 6).

CLAVE PARA LAS ESPECIES DE SOBRALIA DE EL SALVADOR

1. Plantas epífitas, menos de 40 cm de alto, normalmente con 2–3 flores abiertas al mismo tiempo, garganta del labelo blanca con manchas redondas, grandes, de color rojo violeta ____________ **S. amabilis** (Rchb. f.) L.O. Williams
1. Plantas terrestres, más de 40 cm de alto, cada tallo o inflorescencia con sólo 1 flor abierta al mismo tiempo, garganta del labelo normalmente sin manchas o estas no circulares, ni rojo-violeta.

FIG. 3. Hojas de *Sobralia paulancalmoi*, mostrando su habito glabro y la ausencia de manchas o verrugas. Crédito fotográfico: Paul Ancalmo.

FIG. 4. Labelo de *Sobralia paulancalmoi* J. Linares, mostrando la mancha alabardada del labelo. Crédito fotográfico: Paul Ancalmo.

Fig. 5. Flor de *Sobralia paulancalmoi* J. Linares, mostrando el labelo escasamente bilabiado. Crédito fotográfico: Paul Ancalmo.

2. Flores rojo violeta en diferentes grados desde muy pálidas, casi rosado pálido, hasta colores muy intensos, a veces varios tonos en la misma población.
   3. Plantas comúnmente formando brotes vegetativos (keikis) de las inflorescencias viejas; creciendo a menos de 800 msnm (usualmente creciendo en riscos pedregosos, campos de lava o bosques secos); labelo menos de 6 cm de largo (plantas de 800 msnm) __________ **S. decora** Bateman
   3. Plantas nunca formando brotes vegetativos (keikis); creciendo a más 800 msnm (en bosques semihúmedos o húmedos, nunca en campos de lava); labelo más de 6 cm de largo.
      4. Plantas de aspecto desaliñado, laxas, tallos arqueados y con pocas hojas en los tallos floríferos, ocasionalmente con sólo dos hojas al momento de la floración; labelo de menos de 9 cm de largo, ápice muy poco emarginado __________ **S. paulancalmoi** J. Linares
      4. Plantas robustas, densas, tallos rectos y con muchas hojas en los tallos floríferos; labelo de más de 9 cm de largo, ápice profundamente emarginado
         5. Plantas de 1–1.25(–1.5) m de alto, flores moradas, lila o rosado, mancha blanca de la garganta del labelo elíptica a circular con la parte distal redondeada __________ **S. macrantha** Lindl.
         5. Plantas de 1.5–2.5 m de alto, flores magenta o rojo violeta, mancha de la garganta del labelo con forma obcordada, con el ápice de la mancha escotado __________ **S. rogersiana** Christenson
2. Flores de otras combinaciones o colores, no de rojo violeta o sus grados, generalmente blancas o amarillas.
   6. Flores completamente blancas __________ **S. macrantha** var. **kienestiana** Rchb.f.
   6. Flores amarillas, amarillo pálido o amarillo oro __________ **S. xantholeuca** Hort. ex Williams

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Deseo agradecer al Diego Bogarín por la cuidadosa revisión y aportes al mejoramiento del manuscrito, a un revisor anónimo por sus comentarios y recomendaciones, al Ciryl Hardy Nelson Sutherland por la descripción latina así como por sus comentarios, a los colegas Frank Sullyvan Cardoza y Ana Eugenia Aguilar por su apoyo logístico y a Vladlen Henríquez por la elaboración del mapa de distribución. Deseo agradecer al Barney Lipscomb por toda su orientación durante el proceso de edición del presente articulo y su guía eficaz y oportuna en todo momento.

Fig. 6. Flor de perfil de *Sobralia paulancalmoi* J. Linares, mostrando el labelo escasamente bilabiado.

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BOOK REVIEW

Richard Stephen Felger and Benjamin Theodore Wilder (in collaboration with Humberto Romero-Morales). 2012. **Plant Life of a Desert Archipelago: Flora of the Sonoran Islands in the Gulf of California.** (ISBN-13: 978-0-8165-0243-1, hbk.). The University of Arizona Press, P.O. Box 210055, Tucson, Arizona 85721-0055, U.S.A. (**Orders:** uapress.arizona.edu, 1-800-621-2736). $65.00, 624 pp. (incl. 8-page color inset), 388 species accounts with paired distribution maps, hundreds of line drawings and photos, 8 ½" × 11", 3.7 pounds.

The natural history of this region is natural history brought to life and almost animated for you in this superb compendium of information on the Gulf Islands. Anyone working in this region, in any discipline, from beginner to expert, will be delighted by the wealth of detailed information written with heart, cheer, and energy, lighting up the rich human and biological history of this very special region of the world.

This book is packed with rich tales of an island chain almost untouched by invasive plants, with a modern history of many peoples sharing the rich biological resources. Almost every page has a picture, and albeit in black and white, the images and the diverse objects throughout the book leave you yearning to give them color and visit the islands for yourself.

Perhaps the most outstanding feature of the book is the quality of the science behind it, the precision in every story and record and every dot on each map. The authors are meticulous scholars, and every detail has been carefully researched, yet this in no way detracts from the readability. This book is a masterpiece in its ability to be both a thoroughly enjoyable read and a scientific encyclopedia.

Felger took his first trip in 1954, and anyone familiar with Felger's attention to detail will instantly know the quality of this work. Wilder became involved a half-century later in 2005, and his focused studies in recent years bring a contemporary energy to this mammoth volume.

The preface and foreword are both passionately written and convey the very personal connections of the authors to the region. **Part 1—The Islands and Their Vegetation** is an introduction to the geology, biology, ethnobotany, and natural history. It includes a section on invasive species and a section on administration and conservation that boasts a photo of big-horn sheep being moved by helicopter in 2008! **Part 2—Botanical Explorations on the Sonoran Islands: Collectors, Associates, and Selected Personalities** is a delightful compendium of accounts documenting people who have lived and worked in the region. It is packed with tales of adventure and travels in the gulf, giving rich insights into the lives of the big names in gulf biology. **Part 3—The Flora** contains the species accounts, the heart of the research. Each species has a distribution map, and there are many great illustrations, packed with stellar detailed-yet-easily-digestible text. It includes keys to species and the Seri plant names and uses in many cases, often provided by collaborator Humberto Romero-Morales of the Seri nation. And anyone working in the region or researching its history will enjoy the detailed place names in **Part 4—The Gazetteer** as well as the following useful appendices: **Appendix A: Checklist of the Flora of the Sonoran Islands** (summarizing knowledge for each island); **Appendix B: Species Mutually Absent from Isla Tiburón and Mainland Sonora** (an unusual and interesting addition to this volume, almost a watch-list for what might arrive or be found in future); and **Appendix C: Botanical Name Changes.** Lastly, the index and literature cited are exhaustive and excellent.

This book is a must-have for anyone working in the area, but it's also a treasure for anyone that just wishes they were there, a doorway into the magic of the region through the pages of a book.—*Sula Vanderplank, PhD, Biodiversity Explorer, Botanical Research Institute of Texas, Fort Worth, Texas, U.S.A.*

FOUR NEW SPECIES OF *COLUMNEA* (GESNERIACEAE) WITH PRIMARY DISTRIBUTIONS IN COLOMBIA

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ABSTRACT

Recent studies investigating the species of *Columnea* sections *Ortholoma* and *Collandra* have uncovered several new species to science. In the present paper we describe four species, **Columnea ceticeps, C. ferruginea, C. fractiflexa**, and **C. laciniata** with a primary distribution in Colombia as part of ongoing studies in the revised subgeneric classification of the genus and revision of the species of section *Ortholoma.*

RESUMEN

Estudios recientes en el género *Columnea* secciones *Ortholoma* y *Collandra* han revelado varias especies nuevas para la ciencia. En este artículo, como parte de los estudios en curso sobre la clasificación subgenérica del género y la revisión de especies de la sección *Ortholoma*, describimos cuatro especies nuevas **Columnea ceticeps, C. ferruginea, C. fractiflexa**, y **C. laciniata,** con distribución principal en Colombia.

INTRODUCTION

Within Gesneriaceae, classification systems based on morphological characters have been notoriously challenging when trying to align them with evolutionary relationships (Wiehler 1983). Recent molecular work has uncovered multiple cases of para- and polyphyletic genera (Möller & Cronk 1997; Smith et al. 1998, 2004; Smith 2000; Clark & Zimmer 2003; Roalson et al. 2005a, 2005b, 2008; Clark et al. 2006, 2011, 2012; Möller et al. 2009; Wang et al. 2010, 2011). Although the genus *Columnea* has been regularly recovered as monophyletic in molecular systematics studies (Clark et al. 2012), its classification has not been entirely stable as Wiehler (1973, 1983) split the genus into four genera (*Columnea, Dalbergaria, Trichantha*, and *Pentadenia*) and described a fifth, *Bucinellina* (Wiehler 1981). Wiehler considered earlier classifications within *Columnea* s.l. to reflect convergent evolution by pollinator selection on corolla form rather than the evolution of the plants themselves (Wiehler 1983). This split was not widely accepted and alternative subgeneric systems that treated *Columnea* as a single genus were proposed (Morley 1974, 1976; Kvist & Skog 1993; Smith 1994). Currently the genus is estimated to comprise 200 species (Kvist & Skog 1993; Weber 2004; Skog & Boggan 2007).

As part of the process of revising the subgeneric classification and placement of species in section *Ortholoma* (sensu Kvist & Skog 1993; Smith 1994), several specimens have been discovered that do not fit within the range of variation for the previously described species in this section.

Colombia is home to tremendous species diversity in the genus *Columnea* with 90 species recorded there (Clavijo et al. 2011) and numerous recent papers reflect the large number of species yet to be described from this country (Amaya-Márquez 2010a, b; Amaya-Márquez & Marin-Gómez 2012; Amaya-Márquez & Smith 2012; Clark & Clavijo 2012; Clavijo & Clark 2013; Mora & Clark 2012; Amaya-Márquez & Smith submitted).

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Here we describe four species whose primary distribution is in Colombia.

Columnea ceticeps J.L. Clark & J.F. Smith, sp. nov. (**Figs. 1 & 2**). TYPE: COLOMBIA. ANTIOQUIA: Municipio Jardín, Vereda La Mesenia, Reserva Natural Mesenia-Paramillo (Fundación Colibrí), Cordillera Occidental, Sendero Transilvania, from Río San Juan to Cuchilla Paramillo, 2200–2800 m, 5°29'18"N 75°54'20"W, 17 May 2012, *J.L. Clark, J. Anderson, L. Clavijo & U. Rendón 12950* (HOLOTYPE: COL; ISOTYPES: MO, NY, US).

Pendent epiphytic herb with red bilabiate corollas. Differing from other species in section *Columnea* by having a narrow galea curved downward.

Epiphytic herb; stems to 2.8 mm in diameter, red-brown, with zigzag appearance proximally glabrous, distally appressed pilose with multicellular gold-colored trichomes; internodes 1.3–4.8 cm long; leaf scars flush with the stem. **Leaves** opposite, anisophyllous, larger lamina 2.5–8.8 cm long, 0.8–3.0 cm wide, ovate to elliptic, apex acuminate, base oblique, lateral veins 3–5 per side, adaxially green, appressed pilose with multicellular trichomes with more or less pustulate bases, abaxially green, pilose with gold-colored multicellular trichomes, denser on veins, margin crenulate to serrulate; petioles 0.1–0.15 cm long, pilose with multicellular gold-colored trichomes; smaller lamina 1.7–2.5 cm long, 0.7–1.15 cm wide, lateral veins 1–3 per side, petiole 0–0.08 cm long, otherwise similar to larger lamina. **Inflorescence** of 1 flower per axil of leaf; bracts not seen, presumably caducous. Pedicels 9.5–19.5 mm long, green, appressed pilose with multicellular trichomes. Calyx loosely clasping, lobes 14.0–21.0 mm long, 0.8–3.5 mm wide, lanceolate, apex acute, exterior appressed pilose with multicellular gold-colored trichomes and single-celled white trichomes or densely spreading pilose with multicellular gold-colored trichomes (the latter true for most specimens from Nariño), red, interior glabrous; margin subentire to denticulate. Corolla 4.2–6.5 cm long, 0.55–1.4 cm at widest point which is the opening of the throat, tubular, not ventricose, gibbous at base, 0.25–0.35 cm wide at narrowest point at the base, red to orange, exterior pilose with multicellular red-colored trichomes, interior minutely puberulent; limb bilabiate, upper lip formed by the two dorsal and two lateral lobes, lower lip formed by a ventral lobe; dorsal lobes connate, rounded, 0.25–0.55 cm long, 0.5–0.6 cm wide, lateral lobes acute 0.1–0.2 cm long, 0.18–0.3 cm wide, ventral lobe, oblong 1.05–1.8 cm long and 0.14 cm wide, galea 1.8–2.05 cm long. Filaments 1.5 cm long connate 0.25 cm and adnate to corolla another 0.15 cm, tomentose with glandular and non-glandular trichomes, anthers 2.5 mm long, 2.5 mm wide, quadrangular, included in corolla throat. Ovary 4.0 mm long, conical, glabrous, style 34 mm long yellow, minutely puberulent, stigma stomatomorphic, yellow, smooth. Nectary a double dorsal gland. **Fruit and seeds** not seen.

Phenology.—Flowering specimens have been collected from December-February, April, May, and July, presumably flowering continuously, no fruiting specimens are known.

Distribution.—This species is widespread mainly in the Cordillera Occidental of Colombia in the departments of Antioquia, Chocó, Risaralda, Valle, Cauca, Nariño, Putumayo, and Ecuador at elevations from 1900 to 2900 m. In Antioquia the species has been recorded both in Cordillera Occidental and Cordillera Central.

Etymology.—The specific epithet is derived from the combining forms of whale (cetus) and headed (-ceps) due to the similarity of the corolla in profile that looks like a sperm whale's head with an open mouth (Fig. 2).

Additional specimens examined: **COLOMBIA. Antioquia:** Caldas, vereda La Clara. Headwaters of Río Medellín, trail to Alto de San Miguel, Cordillera Central, 12 May 2012, *J.L. Clark et al. 12874* (COL); Jardín, Sector alto de Ventanas, 2 Jul 2007, *H. David et al. 2125* (HUA). **Chocó:** San José del Palmar, Cerro del Torrá, edge of the mountain, 21 Aug 1988, *F.A. Silverstone-Sopkin et al. 4641* (CUVC). **Risaralda:** Santuario, vereda Las Colonias, 2 Feb 1983, *J.H. Torres et al. 1446* (COL). **Cauca:** Cerro Munchique, *F.C. Lehmann 7636* (US); El Tambo, PNN Munchique, 20 Jun 2001, *R. Bernal & P. Lopera 2850* (COL), 8 Feb 2000, *C.E. González & M.M. Olives 2702* (COL), 30 Jul 1993, *G. Lozano et al. 6587* (COL); El Tambito, Centro de Estudios Ambientales del Pacífico Tambito, trail Cerro del Perro, Río Paloverde, 19 Dec 2000, *C.E. González 3354* (COL); La Costa, 7 Sep 1936, *K. von Sneidern 795* (COL), Sep 1936, *K. von Sneidern 796* (COL); El Tambo, 4 Aug 1936 *K. von Sneidern 990* (US), 19 Jul 1993, *F. González et al. 2756* (COL); 7 "La Gallera" El Micay 1 Jul 1922 *E.P. Killip 7935* (US), *Pérez Arbelaez & Cuatrecasas 6266* (COL), *A. Gentry et al. 60502* (MO), 30 Jul 1993, *N. Ruiz et al. 204* (COL); El Cairo, vereda El Brillante, 30 May 2011, *O.-H. Marín-Gómez & D.A. Gómez-Hoyos 196* (COL-2), *197* (COL), *198* (COL). **Nariño:** Ricaurte, Reserva La Planada, 26 May 1985 *O. de Benavides 5553* (US, PSO), 29 Apr 1988 *O. de Benavides 9598* (MO, US, PSO), 17 Jan 1990 *O. de Benavides 11276* (US, PSO), 25 Sep 1989, *O. de Benavides 10809* (PSO), 1 Sep 1990, *O. de Benavides 11447* (PSO); Mpio. de Mallama, camino que conduce de la Planada a Pialapí, 15 Aug 1992, *R. Giraldo 181* (PSO), 13 May 1992, *R. Giraldo 121* (PSO), 3 Mar 1989, *J.F. Smith & M. Galeano 1522* (PSO); Barbacoas, Corregimiento de Altaquer, vereda El Barro, Mar

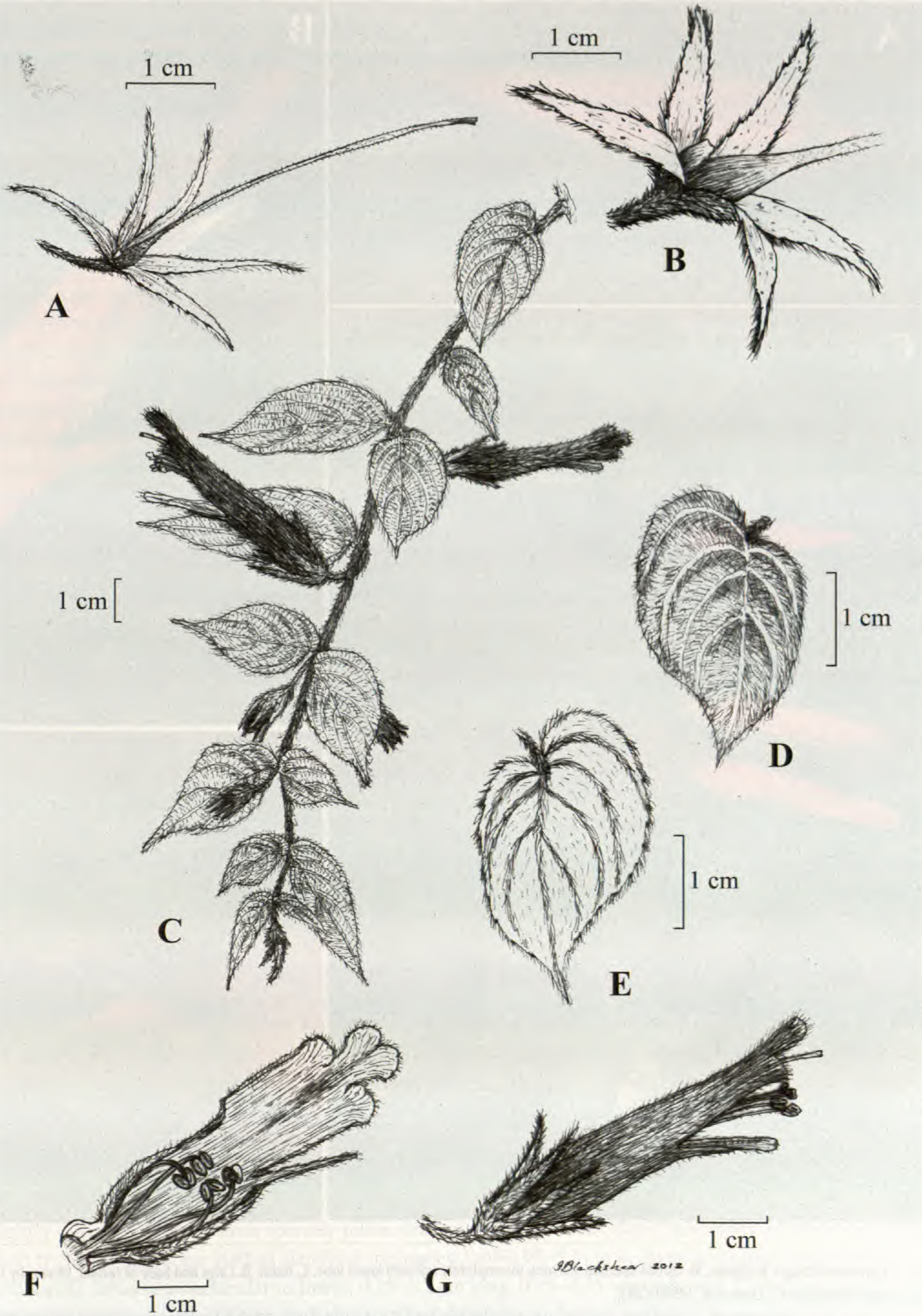

FIG. 1. *Columnea ceticeps*. **A.** Calyx with corolla removed to show gynoecium. **B.** Calyx and base of gynoecium with double dorsal nectary gland. **C.** Habit. **D.** Leaf, adaxial surface. **E.** Leaf, abaxial surface. **F.** Corolla opened to show androecium. **G.** Flower. All from *L. Figueiras 8379* (US). Illustration by Sue Blackshear.

Fig. 2. *Columnea ceticeps*. **A.** Flower. **B.** Corolla opening showing incompletely reflexed lower lobe. **C.** Habit. **D.** Calyx and base of corolla. Photos by J.L. Clark (type collection: *J.L. Clark et al. 12950* (COL)).

1995, *J.L. Fernández et al. 12387* (COL); Reserva Natural Río Ñambi, 25 Dec 2003, *N.R. Salinas et al. 409* (PSO). **Putumayo:** San Francisco, km 83 from the highway to the west, 6 Jun 1973, *O. de Benavides & J. Riascos 71*(PSO); High basin of river Putumayo at the Valle de Sibundoy, 2 Jan 1941, *J. Cuatrecasas 11607* (COL); road between Mocoa and La Siberia, 30 Jan 1961, *G. López 153* (PSO). **Risaralda:** Municipio de Santuario, vereda Las Colonias, 400 m up from the camp, 2 Feb 1983, *J. Torres et. al. 1446* (COL). **Valle:** Cuenca del Rio Cali, 23 Jan 1963 *L. Figueiras 8360* (US, VALLE), *8379* (US, VALLE); El Cairo, Cerro El Inglés, Serranía Las Paraguas, 1 Apr 1988 *F.A. Silverstone-Sopkin et al. 3913* (CUVC, US), May 19 2013, *J.F. Smith et al. 10805* (COL). **Valle/Chocó:** El Cairo, 25 Apr 1989, *J.L. Luteyn & J. Giraldo 12657* (CUVC, US), May 20 2013, *J.F. Smith et al. 10849* (COL); West Cordillera, Observatorio, Aug 1941 *E. Dryander 2506* (US), *2517* (US), Sep 1941 *E. Dryander 2516* (US). ECUADOR. **Carchi:** Canton Tulcan, Parroquia Maldonado, 8 Dec 2001, *J.L. Clark & C. Guiz 6386* (QCNE, MO, US).

Several herbarium specimens were annotated with unpublished names by Wiehler. It is curious that Wiehler considered this species as a member of *Trichantha*, which is a genus that has few species with bilabiate corollas. This species might more likely be placed in section *Columnea*, and corresponding to Wiehler's genus *Columnea* based on the bilabiate non-ventricose corolla with spreading corolla lobes. However, the corolla does not expand to a broadened galea (Fig. 2 A, B) as do all of the species in section *Columnea* and its sectional placement has yet to be tested with molecular data.

The specimens from Nariño, Colombia are marginally different from other collections in that the exterior vesture of the calyx lobes is densely pilose with the characteristic gold-colored trichomes found in other collections but much less dense. This species is similar to another undescribed species from Colombia and which mostly differs from *C. ceticeps* in having leaves that are glabrous adaxially. Although this seems to be a minor difference, pubescence on vegetative parts of species in *Columnea* tends to be consistent and glabrous leaves are an unusual trait, therefore these specimens are considered a different species here.

Columnea ceticeps also is vegetatively similar to yet another undescribed species from Colombia, both of which have been collected from Cerro Munchique. However the corollas are different between the two with the undescribed species having corollas with a subradial limb and *C. ceticeps* with a bilabiate limb (Figs. 1, 2).

Columnea ferruginea J.F. Smith & J.L. Clark, sp. nov. (**Fig. 3**). Type: COLOMBIA. Valle: Municipio El Cairo, Corregimiento El Boquerón, vereda El Brillante, Reserva Natural Cerro El Inglés, 19 May 2013, *J.F. Smith, O.H. Marín Gómez & J. Arango Bermudez 10808* (holotype: COL; isotypes: CUVC, HUA, PSO, VALLE, TULV).

Epiphytic herb similar to *C. dictyophylla* but covered in rust-colored rather than gold trichomes and with less conspicuous tertiary venation on the abaxial surfaces of the leaves.

Epiphytic herb; stems to 115 cm long, up to 5.5 mm diameter, brown, proximally pilose with multicellular rust-colored trichomes, distally denser; internodes 1.0–4.5 cm long; leaf scars raised. **Leaves** opposite, anisophyllous, larger lamina 6.2–10.0 cm long, 1.8–3.1 cm wide, oblanceolate to narrowly oblong, slightly falcate, apex acuminate, base oblique, lateral veins 9–12 per side, adaxially green, appressed pilose with multicellular rust-colored trichomes, abaxially green, pilose with multicellular rust-colored trichomes, slightly denser vesture on veins, margin serrulate and ciliate with multicellular red trichomes; petioles 0.2–0.5 cm long, densely pilose with multicellular rust-colored trichomes, smaller lamina 1.2–2.1 cm long, 0.25–0.6 cm wide, lanceolate, apex acute to acuminate, base oblique, adaxially green, pilose with multicellular rust-colored trichomes, abaxially green, densely pilose with multicellular rust-colored trichomes, denser on veins, margin serrulate, petiole 0.08–0.1 cm long, pilose with multicellular rust-colored trichomes. **Inflorescence** of 1 flower per axil of leaf; bracts 3.5 mm long, 0.2 mm wide, linear, apex acute, red-purple, pilose with multicellular rust-colored trichomes. Pedicels 1.9–2.5 cm long, green or red, densely pilose with multicellular rust-colored trichomes. Calyx loosely clasping, lobes 16.0–27.0 mm long, 1.5–1.8 mm wide, linear, apex acuminate, exterior densely pilose with multicellular rust-colored trichomes, red or bright yellow-green; margin serrulate. Corolla 4.7–6.3 cm long, 0.95–1.4 cm wide at widest point, 0.9–1.25 cm before limb, 0.25–0.3 cm at gibbous base, tubular, slightly ventricose, red, exterior sparsely pilose with multicellular rust-colored trichomes, interior with some short trichomes and some stalked glandular trichomes; limb 0.95–3.3 cm in diameter (widest when lower lobe is reflexed), lobes semi-orbicular to linear, 0.25–1.2 cm long, 0.25–0.35 cm wide, red. Filaments connate 3.5 mm and adnate to corolla 0.7 mm, with short stalked glandular trichomes, anthers 2.8 mm long, 2.8 mm wide, quadrangular, included in corolla tube. Ovary 4.5 mm long, conical, pilose with multicellular transparent trichomes, style pale yellow to white, pilose with multicellular transparent and short stalked glandular tri-

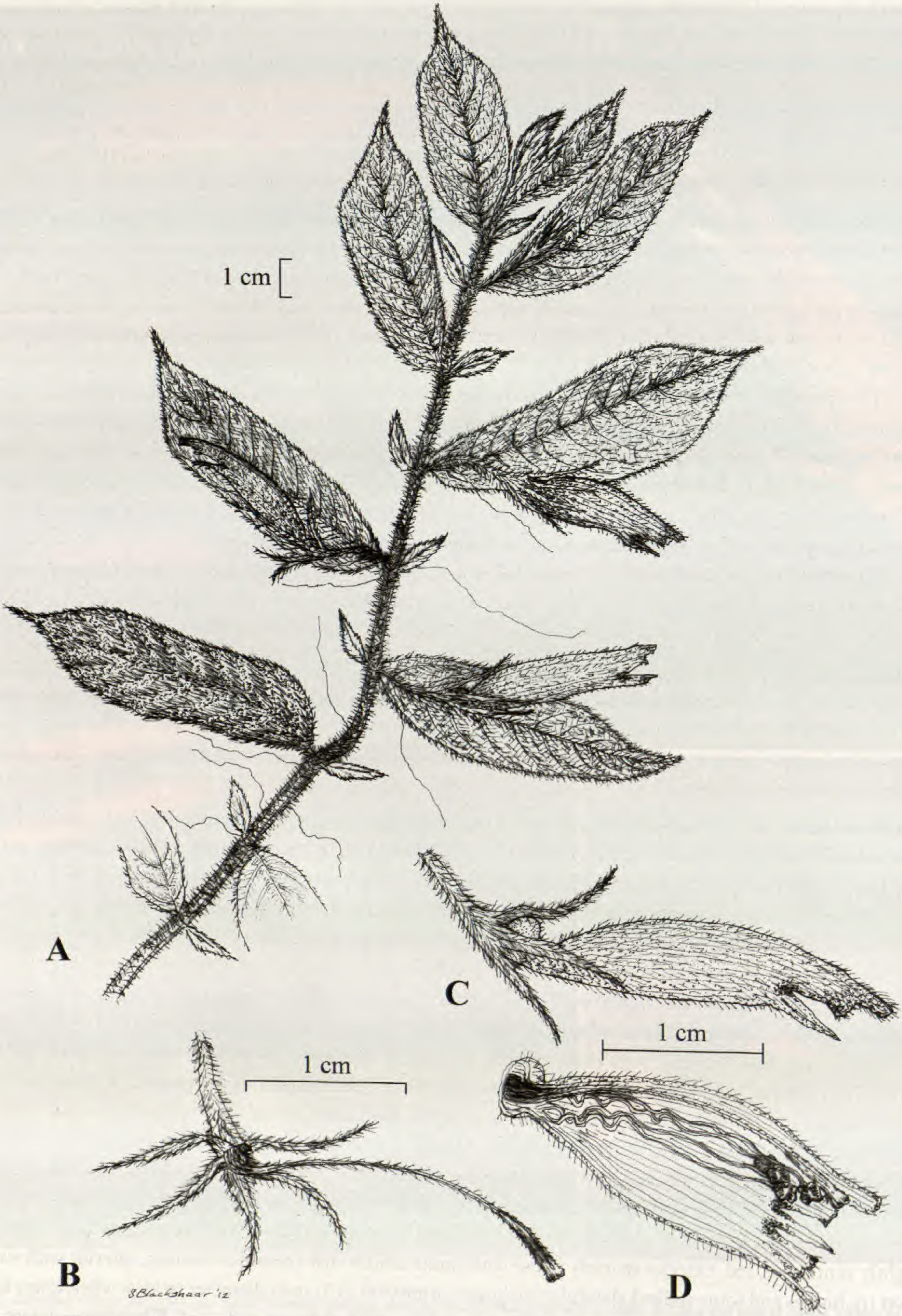

FIG. 3. *Columnea ferruginea*. **A.** Habit. **B.** Calyx and gynoecium with corolla removed. **C.** Flower. **D.** Corolla opened to show androecium. All illustrations from *J.L. Luteyn et al. 12346* (NY). Illustration by Sue Blackshear.

chomes, stigma bilobed, papillate, included in corolla tube. Nectary a dorsal double gland. **Fruit and seeds** not seen.

Phenology.—Flowering only known from January and May, fruits not seen.

Distribution.—Apparently a rare species found in Colombia between 2000–2320 m along the western slopes of the Cordillera Occidental.

Etymology.—The specific epithet is derived from the rust-colored trichomes that cover most of the vegetative portions of this species.

Additional specimens examined: **COLOMBIA. Valle:** Municipio El Cairo, Serranía de los Paraguas, Reserva Natural Cerro El Inglés, 1 Jan 1987, *F.A. Silverstone-Sopkin 2850* (US); Corregimiento Boquerón, Vereda La Amarillas, Serranía de los Paraguas, Cerro El Inglés, 14 May 1988, *J.L. Luteyn et al. 12346* (NY, US), 19 May 2013, *J.F. Smith et al. 10772* (COL); Sector La Florida, camino Los Santicos a La Florida a Río Blanco, 20 May 2013, *J.F. Smith et al. 10829* (COL), *J.F. Smith et al. 10830* (COL).

Columnea ferruginea is readily differentiated from all other congeners by the distinctive rust-colored vesture on the abaxial leaf surface. It is similar to *C. dictyophylla* Donn. Sm. in that it also has a large, red, bilabiate corolla, but differs in lacking the distinctive gold vesture of the abaxial leaf surface. Additionally, the tertiary leaf venation in *C. dictyophylla* is reticulate, abaxially prominent, and covered in hairs that contrast with the often red-purple color of the lamina. The tertiary venation of *C. ferruginea* is suppressed and inconspicuous.

Columnea fractiflexa J.F. Smith & J.L. Clark, sp. nov. (**Figs. 4 & 5**). TYPE: COLOMBIA. ANTIOQUIA: Municipio Urrao, Corregimiento La Encarnación, Vereda Calles, Parque Nacional Natural Las Orquídeas, camino Calles-La Encarnación, después de la confluencia del río Polo y antes del río San Pedro, sitio la Quiebra, 06°30'31"N, 76°14'W, 1600–1850 m, 31 Jan–2 Feb 2011, *P. Pedraza-Peñalosa, J. Betancur, M.F. González, G. Giraldo, F. Gómez, A. Duque & J. Serna 2137* (HOLOTYPE: COL; ISOTYPES: NY, UNA).

Pendent epiphytic herb similar to *C. minor* but with smaller leaves, a corolla that is entirely red, and lacking appendages that alternate between the corolla lobes.

Pendent to festooning epiphytic herb; stems to 1.5 mm diameter with a characteristic zigzag appearance, tan, proximally sparsely appressed pilose with multicellular red-colored trichomes, distally denser; internodes 2.0–2.2 cm long; leaf scars slightly raised. **Leaves** opposite, anisophyllous, larger lamina 2.8–4.5 cm long, 0.85–2.8 cm wide, ovate, apex acute, base obtuse and slightly oblique, lateral veins 4–7 per side, adaxially red, densely appressed pilose with multicellular red-colored trichomes, abaxially red, sparsely appressed to spreading pilose with multicellular yellowish trichomes, denser on veins, margin serrulate; petioles 0.1–0.15 cm long, pilose with multicellular red-colored trichomes, smaller lamina 0.6 cm long, 0.2 cm wide, lanceolate, sessile, otherwise similar to larger lamina. **Inflorescence** of 1–2 flowers per axil of leaf; bracts 8.0 mm long, 1.5 mm wide, lanceolate, apex acute, green, sparsely pilose with multicellular red-colored trichomes. Pedicels 8.0–11.0 mm long, green, densely appressed to spreading pilose with multicellular red-colored trichomes. Calyx clasping, lobes 7.0–8.0 mm long, 8.0–10.0 mm wide including lobes to the tips of the lobes, ovate, apex acuminate, exterior spreading pilose with multicellular red-colored trichomes, green, interior glabrous; margin deeply fimbriate. Corolla 4.4–5.1 cm long, 0.74–1.0 cm wide at widest point, 0.6–0.95 cm before limb, 0.3–0.35 cm at base, tubular, slightly ventricose, somewhat falcate, gibbous at base, red, exterior sparsely spreading pilose with multicellular trichomes, interior sparsely pilose inside throat dorsally, otherwise glabrous; limb slightly bilabiate, 0.85–1.22 cm in diameter, lobes elliptic, 0.45 cm long, 0.2 cm wide, red. Filaments 47 mm long connate for 8.0 mm and adnate to corolla an additional 0.5 mm, glabrous, anthers 1.7 mm long, 1.4 mm wide, quadrangular, included in corolla tube. Ovary 3.0 mm long, conical, sparsely pilose with multicellular trichomes, style 49 mm long, yellow, glabrous, stigma bilobed, papillate, included in corolla tube. Nectary two dorsal double glands. **Fruit and seeds** not seen, but the label of the type collection indicates the fruits are pinkish-white.

Phenology.—Flowering known from January, April, May, July, and November. Fruits not seen, but are referred to in the type collection made in January.

Distribution.—This species is known only from a narrow region in Antioquia Colombia where all specimens have been collected from 1600–2050 m.

Etymology.—The specific epithet is derived from the zigzag appearance of the pendent stems (Fig. 5B).

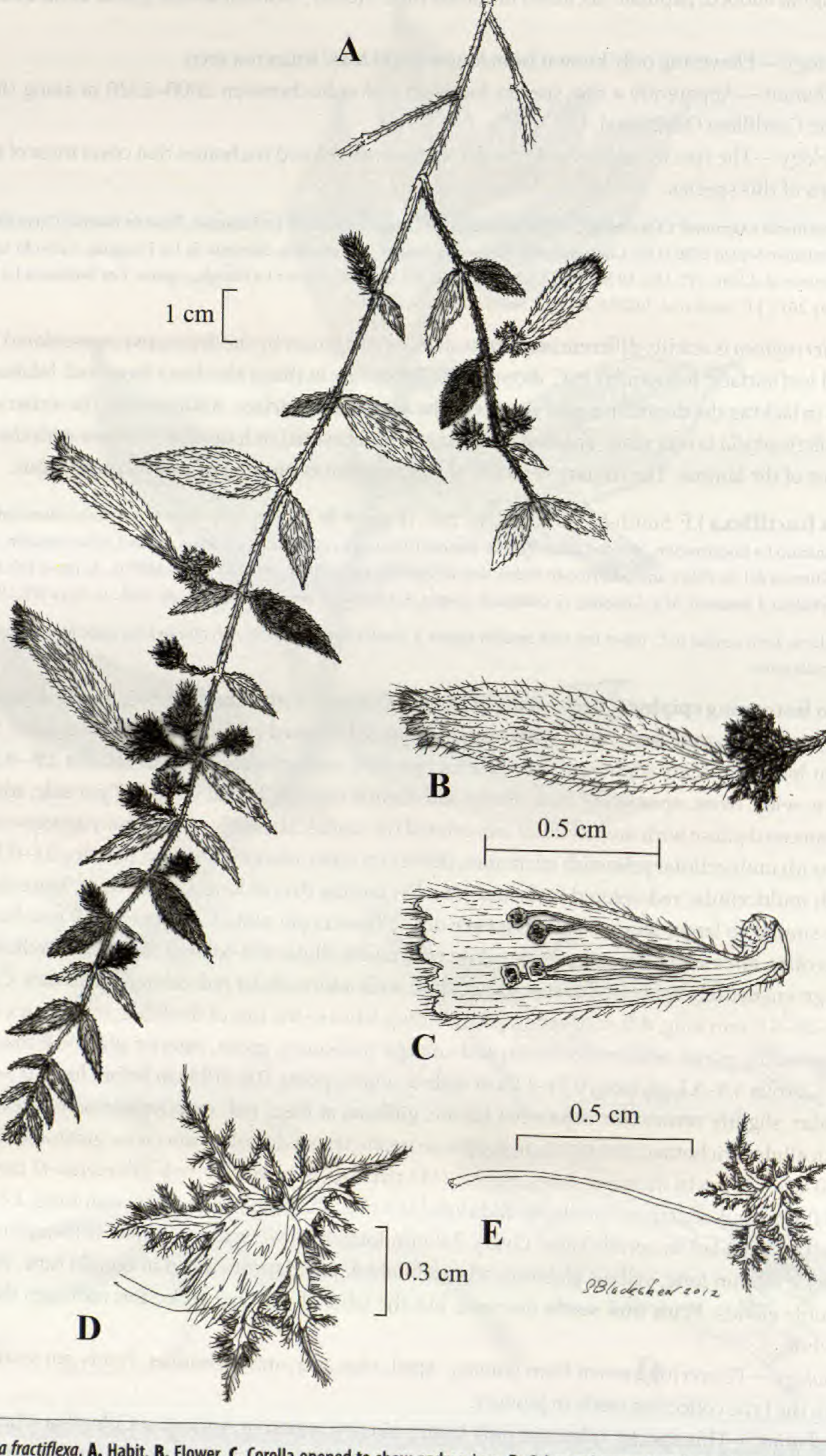

Fig. 4. *Columnea fractiflexa*. **A.** Habit. **B.** Flower. **C.** Corolla opened to show androecium. **D.** Calyx and ovary. **E.** Calyx with corolla removed to show gynoecium. All from *J.C. Betancur et al. 428* (MO). Illustration by Sue Blackshear.

FIG. 5. *Columnea fractiflexa*. **A.** Flower. **B.** Habit showing zigzag stem and abaxial leaf surface. **C.** Habit showing zigzag stem and adaxial leaf surface. Photos by Paola Pedraza.

Additional specimens examined: **COLOMBIA. Antioquia:** Municipio de Frontino, Nov 1975, *R. Escobar R. s.n.* (SEL), 4 May 1983, *C. Luer et al. 8997* (SEL, US); Municipio de Frontino, Región Murrí, lado de la carretera entre Nutivara y La Blanquita, despues del Alto de Cuevas, 06°43'N, 76°19'W, 1380 m, 13 Apr 1987, *J.C. Betancur et al. 428* (MO-2, NY, US); 14 July 1988, *R. Callejas et al. 6817* (MO, US); 3 Nov 1988, *G. McPherson 12949* (MO); trail from Encarnación to Parque Nacional de los Orquídeas, 1600–1800 m, 27 Jan 1979, *A. Gentry & E. Renteria A. 24559* (COL, MO, US).

Columnea fractiflexa is similar to *C. minor* by the presence of tubular subradial red corollas and pendent to festooning habit (Figs. 4, 5). The leaves of *Columnea fractiflexa* are significantly smaller (< 4 cm) than *C. minor* (> 5 cm). The presence of corolla appendages alternate between the corolla lobes found in *C. minor* are absent in *C. fractiflexa*. Other species that have pendent habits are mostly confined to a section of *Columnea* (section *Columnea*) that is characterized by strongly bilabiate corollas. The subradial corolla of *Columnea fractiflexa* (Fig. 5A) is different from the strongly bilabiate corollas in section *Columnea*.

Columnea laciniata J.L. Clark & M. Amaya, sp. nov. (**Fig. 6**). TYPE. COLOMBIA. VALLE: Municipio El Cairo, Corregimiento El Boquerón, vereda El Brillante, Reserva Natural Cerro El Inglés, 19 May 2013, *J. F. Smith, O. H. Marín-Gómez & J. Arango Bermudez 10806* (HOLOTYPE: COL; ISOTYPE: CUVC, PSO, TULV, VALLE).

Different from other congeners by the presence of laciniate margins on the sepals. Similar to *Columnea fimbricalyx* by the presence of fimbriate-laciniate calyx margins. Differs from *Columnea fimbricalyx* by presence of broadly ovate leaves in contrast to narrowly lanceolate leaves. The calyx lobes in *C. laciniata* are spreading and separate in contrast to adjacent lobes that appear congested in *C. fimbricalyx*.

Epiphytic herb; stems to 50 cm, up to 3.5 mm diameter, brown, woody at base of stems, proximally nearly glabrous to sparsely pilose with multicellular transparent trichomes, distally denser with multicellular transparent and red-colored trichomes; internodes 1.5–7.2 cm long; leaf scars raised. **Leaves** opposite, anisophyllous, appearing alternate as the smaller leaf is often lost on older portions of stems, larger lamina 3.2–6.8 cm long, 1.6–3.5 cm wide, ovate to elliptic, apex acuminate, base oblique, lateral veins 4–7 per side, adaxially green, sparsely pilose with multicellular transparent trichomes, abaxially red-purple, sparsely pilose with multicellular transparent trichomes to nearly glabrous, slightly denser vesture on veins, margin entire; petioles 0.5–0.8 cm long, appressed pilose with multicellular red-colored trichomes, smaller lamina 1.3–4.2 cm long, 0.25–2.0 cm wide, ovate to lanceolate, apex acuminate, base oblique, lateral veins 4–5 per side, adaxially green, pilose with multicellular transparent trichomes to nearly glabrous, abaxially red-purple, sparsely pilose with multicellular transparent trichomes to nearly glabrous, margin entire to crenulate, petiole 0.3–0.45 cm long, appressed pilose with multicellular red-colored trichomes. **Inflorescence** of 1–2 flowers per axil of leaf; bracts 3.5–6.0 mm long, 0.4–0.7 mm wide, linear, apex acute, red-purple, pilose with multicellular transparent trichomes. Pedicels 5.0–8.0 mm long, red-purple, appressed pilose with multicellular transparent or red-colored trichomes. Calyx loosely clasping, lobes 14.0–20.0 mm long, 1.0–1.5 mm wide without laciniae, elliptic to lanceolate, apex acute, interior glabrous, exterior pilose with multicellular transparent or red-colored trichomes, red-purple; margin laciniate. Corolla 2.3–3.6 cm long, 0.35–0.45 cm wide at widest point along the tube, 0.35–0.5 cm before limb, 0.2 cm at gibbous base, tubular, slightly ventricose, yellow, exterior pilose with multicellular red-colored trichomes, interior glabrous; limb 0.55–0.7 cm in diameter, lobes semi-orbicular, 0.2–0.3 cm long, 0.2–0.3 cm wide, yellow. Filaments connate 5.5 mm and adnate to corolla 0.5 mm, glabrous, anthers 1.7 mm long, 1.7 mm wide, quadrangular, included in corolla tube. Ovary 1.5 mm long, conical, pilose with multicellular transparent trichomes, style yellow, glabrous, stigma bilobed, papillate included in corolla tube. Nectary two dorsal double glands. **Fruit and seeds** not seen.

Phenology.—Flowering only known from September, December, February to May, fruits not seen.

Distribution.—A rare species from Colombia and bordering northern Ecuador between 800–2430 m.

Etymology.—The specific epithet is derived from the laciniate margins of the calyx lobes.

Additional specimens examined: **COLOMBIA. Chocó:** Carretera Cartago-San José del Palmar, Km 65, 15 Nov 1978, *G. Lozano C. & J. Diaz 3079* (COL); Municipio San José del Palmar, carretera Alto Galapagos a San José del Palmar, 22 May 2013, *J.F. Smith et al. 10875* (COL). **Nariño:** El Páramo between Río Ñambí and Río Naspi, 1 Feb 1945, *J.A. Ewan 16814* (MO). **Valle:** Municipio El Cairo, Serranía de Los Paraguas, 2 Apr 1988, *P. Silverstone-Sopkin et al. 3967* (US); Reserva Natural Cerro del Inglés, 19 May 2013 *J.F. Smith et al. 10768* (COL). **ECUADOR. Carchi:** above Río Verde, 3 Dec 1987, *W.S. Hoover 2292* (MO, US), 4 Dec 1987, *W.S. Hoover 2321* (MO-2). **Imbabura:** Ibarra-San Lorenzo, Cachaco-Santa Rosa de Huanchaco, 16 Mar 1991, *A. Hirtz et al. 5253* (SEL).

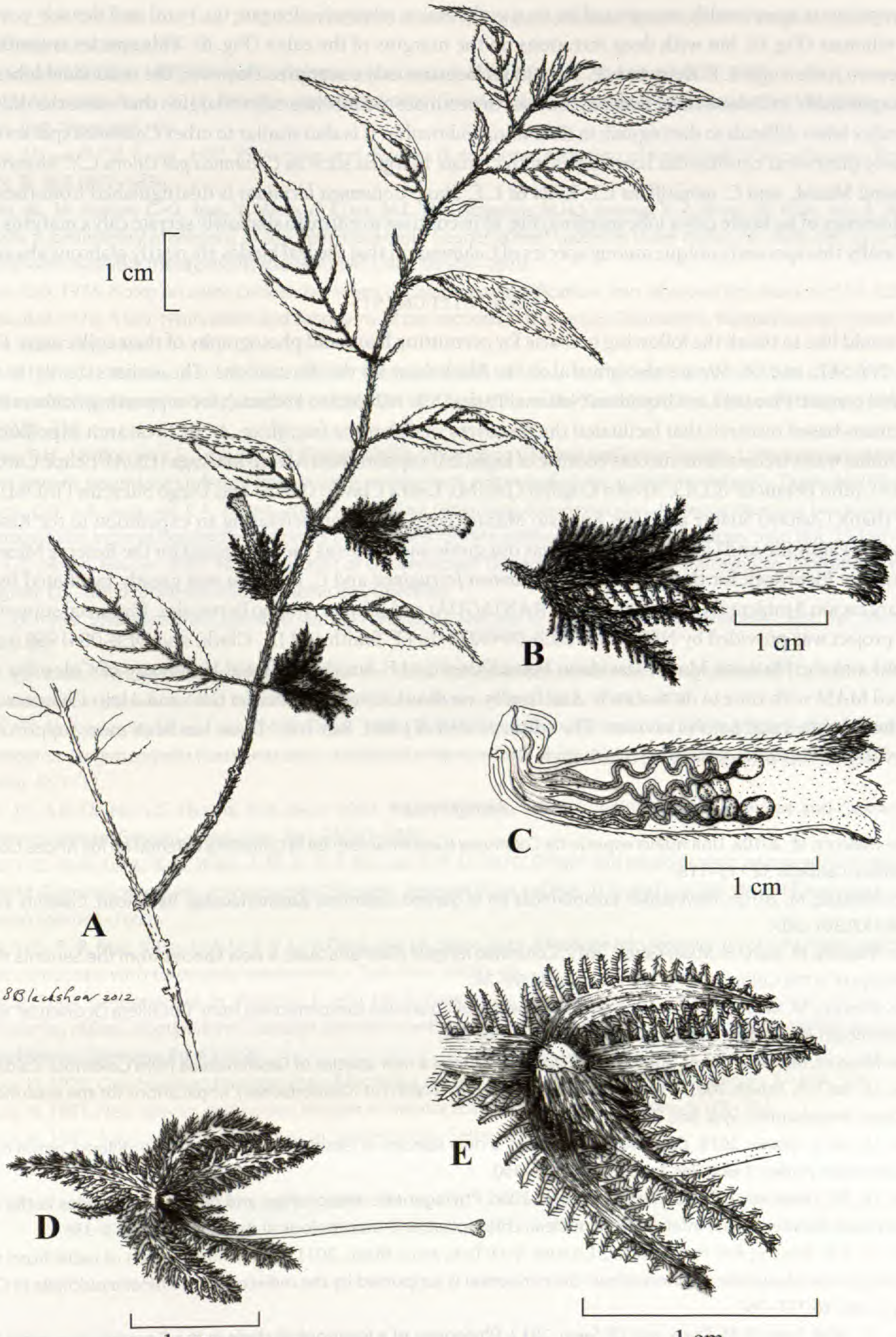

Fig. 6. ***Columnea laciniata*. A.** Habit. **B.** Flower. **C.** Corolla opened to show androecium. **D.** Calyx and gyneocium with corolla removed. **E.** Enlarged view of D showing the ovary and double dorsal nectary gland. All illustrations from *J.A. Ewan 16814* (MO). Illustration by Sue Blackshear.

This species is most readily recognized by its corolla that is relatively elongate (to 3 cm) and densely covered in trichomes (Fig. 6), but with deep serrations on the margins of the calyx (Fig. 6). This species is similar to *Columnea fimbricalyx* L.P. Kvist & L.E. Skog in its laciniate calyx margins. However, the individual lobes are distinguishable in *Columnea laciniata* in contrast to pectinate to fimbriate calyx margins that make the individual calyx lobes difficult to distinguish in *Columnea fimbricalyx*. It is also similar to other *Columnea* species with densely pubescent corollas but have leaves with crenate margins such as *Columnea parviflora* C.V. Morton, *C. lehmanii* Mansf., and *C. minutiflora* L.P. Kvist & L.E. Skog. *Columnea laciniata* is distinguished from these by the presence of laciniate calyx lobe margins (Fig. 6) in contrast to entire to shallowly serrate calyx margins. Additionally this species is unique among species of *Columnea* in that the leaf blades are nearly glabrous abaxially.

ACKNOWLEDGMENTS

We would like to thank the following herbaria for permitting loans and photography of their collections: COL, MO, NY, SEL, and US. We are also grateful to Sue Blackshear for the illustrations. The authors thank the NSF funded project: Flora of Las Orquídeas National Park (DEB 1020623 to Pedraza), for supporting fieldwork and specimen-based research that facilitated the discovery of *Columnea fractiflexa*. A 2012 research expedition to Colombia was a tremendous success because of logistical support from Álvaro Idárraga (HUA), Felipe Cardona (HUA), Julio Betancur (COL), Álvaro Cogollo (JAUM), Laura Clavijo (UNA) and Diego Suescún (JAUM). We also thank Gustavo Suárez and Luis Augusto Mazariegos-Urtado for facilitating an expedition to the Reserve Mesenia-Paramillo and Uriel Rendón who was our guide and serves as the park guard for the Reserve Mesenia-Paramillo. Fieldwork for the discovery of *Columnea ferruginea* and *C. laciniata* was greatly facilitated by the Organización Ambiental Comunitaria (SERRANIAGUA) and Johnier Arango Bermudez. Financial support for this project was provided by NSF grants DEB-0949270 (to J.F. Smith and J.L. Clark) and DEB-0841958 (to J.L. Clark) and the Marjorie Moore Davidson Foundation (to J.F. Smith). National University of Colombia supported MAM with time to do research. And finally, we thank Christian Feuillet (US) and Alain Chautems (G) for their detailed and helpful reviews. The editorial staff at J. Bot. Res. Inst. Texas has been most supportive at every step in this process and we thank them.

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BOOK REVIEW

George Yatskievych. 2013. **Steyermark's Flora of Missouri, Volume 3: Dicots, Fabaceae (subfamily Faboideae) through Zygophyllaceae.** (ISBN-13: 978-0-915279-13-5, hbk). Missouri Botanical Garden Press, P.O. Box 299, Saint Louis, Missouri 63166-0299, U.S.A., in cooperation with the Missouri Department of Conservation, P.O. Box 180, Jefferson City, Missouri 65201-0180, U.S.A. (**Orders:** www.mbgpress.info, orders@mbgpress.org, 1-877-271-1930). $65.00, xvii + 1382 pp., 194 plates of b&w line drawings, 20 figures (incl. 27 b&w photographs), 798 distribution maps, 7" × 10" × 2.5".

At long last, the final treatment of the revision to Julian Steyermark's (1963) *Flora of Missouri* has been completed by the state's premier botanist. Volume 3 is so well written, organized, and illustrated that it is hard to find fault. The late Steyermark is someone the author has always looked up to, and a quote from Yatskievych's acknowledgements is worth repeating here. "Julian Steyermark is a model of what a botanist should be, and his high standards of scholarship are something I continue to aspire to, but fear I will never reach." In completing all three volumes of the revision to Missouri's flora, not only has Yatskievych reached Steyermark's standards, he has exceeded them, and if Julian was still with us I am sure he would concur. Volume 3 covers the Fabaceae (where Volume 2 left off) through the Zygophyllaceae and includes treatments on 1,031 species, 65 infra-specific taxa, and 134 hybrids. All told, the entire three-volume set is no less than 3,554 pages long and includes 582 plates and 2,726 county distribution maps involving 2,839 species and 3,166 taxa.

As in Volumes 1 and 2, one outstanding feature of Volume 3 is the thoroughness of the treatments, not only regarding taxonomy, description, and potential confusion with similar or closely related taxa, but the wealth of information on history, natural history, economic and commercial value, status in cultivation, invasiveness, conservation value, chemical properties, medicinal value, and changes in distribution where applicable. There is only the need to cite but one comment (page 1055) to prove my point. In his treatment of the genus *Populus* Yatskievych mentions "...and poplar wood also was a popular material for stakes to strike through a vampire's heart." **No one** other than George Yatskievych would dig up such an interesting tidbit and include in a flora! The completeness of the treatments is reflected in the fact that the author cited no less than 1,369 references!

Another highlight of the book is the contribution by 16 specialists and 10 separate illustrators. Despite the individuality of contributors, there is amazing continuity throughout the book. The excellent detail and enlargement of flowers, fruits, and leaf vestiture, as well as illustrations of habit by all artists is certainly one of the noteworthy features of the book. Another highlight is that some of the most difficult treatments were contributed by individuals who are recognized experts on various taxa (e.g. Jay Reveill on various legumes, James B. Phipps on *Crataegus*, and Mark P. Widrlechner on *Rubus*). Thus, it would be hard to argue taxonomy on some of the more controversial taxa. Another positive point about the book is that the genus *Rubus* includes subgeneric and sectional keys using a combination of primocanes and floricanes as well as inflorescence characters. Similarly, keys to *Lespedeza*, *Populus*, and *Salix* include both vegetative and reproductive characters involving flowers and fruit. The author is well known for his wit and sense of humor so the illustration of him adjacent to a live specimen of *Frasera caroliniensis* on page 231 (plate 421) for scale is quite hilarious, and the illustrator John Myer should be commended on the amazing likeness of the drawing that includes Yatskievych in typical form with his beard, hat, bald head, glasses, hanging plant press, and even hand clippers well depicted!

I suppose that all book reviewers are expected to find at least a few negative aspects for every book written, especially for one that is 1,382 pages in length, but I must confess that it was difficult to find anything to complain about. Nonetheless, there are a few worth mentioning. The most obvious flaw is the fact that there is no family key but simply the following statement on what would be page xviii; "The key to dicot families will appear in a supplementary publication." This is most unfortunate because no time table has been given when such a publication will ever be completed. We can only hope that it is sooner rather than later, especially given so many taxonomic changes in various dicot families. Another negative mark is that the key to legume subfamilies is not repeated in Volume 3. Anyone needing to key out an unknown legume must potentially use both Volume 2 and Volume 3, and if

(continued on p. 692)

NEW RECORDS AND NOTES ON SPECIES FROM PARC NATIONAL PIC MACAYA, MASSIF DE LA HOTTE, HAITI, INCLUDING A NEW SPECIES OF *PILEA* (URTICACEAE)

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ABSTRACT

Nineteen species new to the flora of the Macaya Biosphere Reserve (including Parc National Pic Macaya) are reported, along with notes on five additional species. The Hispaniolan endemic *Cyperus picardae* is reported as new to the Massif de la Hotte, and a new species of **Pilea, P. vermicularis** (Urticaceae), from the Massif de la Hotte, is described and illustrated.

KEY WORDS: Haiti, Macaya Biosphere Reserve, Massif de la Hotte, *Pilea*

RESUMEN

Se reportan diecinueve especies nuevas de flora de la Reserva Biósfera Macaya (incluyendo Parc National Pic Macaya) y añadimos notas sobre cinco especies adicionales. La endémica de La Española, *Cyperus picardae*, es reportada como nueva para el Massif de la Hotte, y una nueva especie de **Pilea, P. vermicularis** (Urticaceae), del Massif de la Hotte, se describe e ilustra.

PALABRAS CLAVES: Haití, Reserva de la Biósfera Macaya, Masizo de la Hotte, *Pilea*

Parc National Pic Macaya is located near Ville Formon in the Massif de la Hotte, ca. 36 km northwest of Les Cayes, Haiti, encompassing ca. 2000 hectares (Judd 1987; Woods et al. 1992). The flora, plant communities, land-use patterns, and history of biological exploration in the region are outlined in Judd (1987), Judd et al. (1990, 1998), Woods and Ottenwalder (1992), Woods et al. (1992), and Sergile et al. (1992). The majority of Haiti's remaining undegraded natural forest lies within the boundaries of Parc National Pic Macaya and the country's other national park, Parc National Morne La Visite, in southeast Haiti. Parc National Pic Macaya provides refuge for numerous endemic species (Woods et al. 1992, Rimmer et al. 2005, Huber et al. 2010), and is the watershed for the agricultural region of the Plain of Les Cayes to the south (Woods et al. 1992). In 1987 the government of Haiti established the ca. 16,000 hectare Pic Macaya Biosphere Reserve, with the goal of protecting and rehabilitating the biologically diverse forests of Pic Macaya National Park while fostering sustainable development of the surrounding buffer zone (Sergile et al. 1992). For a map of Parc National Pic Macaya, see Judd (1987).

Below we list species newly documented as occurring in Parc National Pic Macaya, along with previously documented species for which we provide additional information based on recent observations. Most of these records are based on collections made by the first three authors (L.C. Majure, G.M. Ionta, and J.D. Skean, Jr.) during field work in the region in January, 2013. However, a few species are listed based on reconsideration of earlier collections made by J.D. Skean or W.S. Judd. The taxa are listed in alphabetical order by family with entries following the format of Judd et al. (1990, 1998). A complete set of voucher specimens is deposited at the

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herbarium of the University of Florida, Gainesville (FLAS). A second set comprised of the collections made in 2013 is deposited with William Cinea at the American University of Les Cayes, and additional duplicates will be distributed. Taxa endemic to Hispaniola (*) or the Massif de la Hotte (+) are indicated.

Asteraceae

* **Mikania polychaeta** Urb.; vine, occasional; opening in forest dominated by *Pinus occidentalis* Sw., associated with *Gleichenia* sp., *Miconia subcompressa* Urb., *M. umbellata* (Mill.) Judd & Ionta, *Piper* sp., *Renealmia jamaicensis* (Gaertn.) Horaninow, and *Rhytidophyllum auriculatum* Hook., 1466 m. This species is a new record for Parc National Pic Macaya.

Voucher specimen: **HAITI. Département du Sud:** Massif de la Hotte, Parc National Pic Macaya, S slopes of Morne Formon, Pic Le Ciel, 18.34584°N, 74.02220°W, 10 Jan 2013, *L.C. Majure 4309* (FLAS).

Begoniaceae

* **Begonia** cf. **bolleana** Urb. & Ekman; herb, uncommon; disturbed rak bwa (i.e., moist broadleaved forest over karstic limestone) in mostly cleared forest, associated with *Miconia navifolia* Ionta, Judd, & Skean, ca. 900 m. This species is a new record for the Macaya Biosphere Reserve.

Voucher specimen: **HAITI. Département du Sud:** Massif de la Hotte, Soulet, Formon trail between Sou Bwa and Les Platons, karst hills, 18.29365°N, 73.99418°W, 15 Jan 2013, *L.C. Majure 4318* (FLAS).

Cyperaceae

* **Cyperus picardae** Boeck. var. **brevinux** Kük.; herb, uncommon; growing out of heavy, disturbed, limestone soils, in cleared forest, associated with *Bactris plumeriana* Mart., *Bunchosia haitiensis* Urb. & Niedz., *Calycogonium hispidulum* Cogn., *Miconia curvipila* (Urb. & Ekman) Ionta, Judd, & Skean, *Miconia laevigata* (L.) DC., *Mecranium multiflorum* (Desr.) Triana, *Neea demissa* Heimerl, *Smilax havanensis* Jacq., and *Tabebuia berteri* (DC.) Britt., 728 m. Although *C. picardae* var. *brevinux* was collected outside of the Parc National Pic Macaya, this species was previously only known from the Massif de la Selle in eastern Haiti. This collection represents a significant range extension of the species to the west and the first collection of the species from the Massif de la Hotte.

Voucher specimens: **HAITI. Département du Nippes (formerly Grand' Anse):** Massif de la Hotte, Morne Salagnac, ca. 14.8 km SW of Miragoane, 7.2 km S of Petite-Rivière de Nippes and 4 km W of Bois Cabrit, 18.411072°N, 73.225369°W, 17 Jan 2013, *L.C. Majure 4322* (FLAS, NY, VAL).

* **Rhynchospora domingensis** Urb.; herb, uncommon; moist, rich slopes in heavy soils of cloud forest dominated by *Pinus occidentalis*, *Alsophyllus* sp., *Brunellia comocladifolia* Humb. & Bonpl., and *Cyathea* sp., also associated with *Mecranium microdyctium* Urb. & Ekman, *Miconia xenotricha* Urb. & Ekman, and *Rhynchospora elongata* Boeck. var. *ekmanii* (Urb.) Kük., ca. 1878 m. This species is a new record for Parc National Pic Macaya.

Voucher specimens: **HAITI. Département du Sud:** Massif de la Hotte, Parc National Pic Macaya, S slopes of Morne Formon, 18.35160°N, 74.021290°W, 13 Jan 2013, *L.C. Majure 4307* (FLAS, NY).

Melastomataceae

+ **Calycogonium ekmanii** Urb.; small tree 2.5 m, rare, a single sterile individual; in rak bwa; 998 m. This species was collected in an extremely disturbed area growing in patches of cut-over forest with *Illicium hottense* A. Guerrero, Judd & A.B. Morris, *Meriania brevipedunculata* Judd & Skean, *Miconia (Sagraea) polychaete* (Urb. & Ekman) Ionta, Judd, & Skean, *M. pyramidalis* (Desr.) DC., and *M. subcompressa*. This collection is a new record for Parc National Pic Macaya.

Voucher specimens: **HAITI. Département du Sud:** Massif de la Hotte, Parc National Pic Macaya, S edge of Ravine Casco in sight of the waterfall, 18.32931°N, 74.00191, 9 Jan 2013, *J.D. Skean, Jr. 5045* (FLAS, NY).

+ **Calycogonium formonense** Judd, Skean & Clase; shrub to 1.5 m, rare; in rak bwa, see Judd et al. (2008) for list of associates, 950–1200 m. Specimens initially identified and reported by Judd (1978) as *C.* cf. *calycopteris*

(Rich.) Urb. and later as *C. hispidulum* (Judd et al. 1998) were later recognized as representing a new species, *C. formonense,* which is endemic to the Massif de la Hotte, and likely to the Macaya Biosphere Reserve (see Judd et al. 2008). *Calycogonium* is polyphyletic (Michelangeli et al. 2008) and this species (along with its relatives) is being transferred to *Miconia* (Judd et al., in press).

Voucher specimens: see Judd et al. (2008).

+ **Henriettea hotteana** (Urb. & Ekman) Alain; shrub ca. 2 m tall, rare, mixed pine/cloud forest with *Arthrostylidium haitiense* (Pilger) Hitchc. & Chase, *Calyptranthes hotteana* Urb. & Ekman, *Alsophila* sp., *Weinmannia pinnata* L., *Phoradendron* sp., 2219 m. This species is a new record for Parc National Pic Macaya.

Voucher specimens: **HAITI. Département du Sud:** Massif de la Hotte, Parc National Pic Macaya, along trail of Pic Formon, 18.35782°N, 74.02687°W, *G.M. Ionta 2031* (FLAS, NY).

+ **Mecranium** sp.; or small tree to 4.5 m tall in rak bwa, uncommon, 979–1188 m. This entity, previously known from a single earlier collection, i.e., *Skean 2093* (FLAS, IJ, S, US), was considered by Skean (1993) to be a putative hybrid between *Mecranium haitiense* Urb. and *M. revolutum* Skean & Judd. Our additional collections indicate that this entity is much more widespread in the Formon region than previously thought, and it may represent an undescribed species. All collections have been sterile and found in areas where *M. haitiense* and *M. revolutum* are common. The plants commonly have red, scurfy abrasions apparently caused by some type of pathogen; the material is currently under study by J. Dan Skean, Jr.

Voucher specimens: **HAITI. Département du Sud:** Massif de la Hotte, Parc National Pic Macaya, Deron Plain; rak bwa above/behind Kay Michele Aubrey "Experiment Station," 18.33143°N, 74.00317°W, 14 Jan 2013, *G.M. Ionta 2046* (FLAS); Bwa Deron, W of Ville Formon, growing out of rak bwa, 18.32648°N, 74.020090°W, 14 Jan 2013, *L.C. Majure 4312* (FLAS); Bwa Formon, S of Morne Formon, along road from Sou Bwa to Ville Formon, karst hills, 18.31878°N, 74.00922°W, 8 Jan 2013, *J.D. Skean, Jr. 5037* (FLAS, NY); near the crest along the Sou Bwa–Ville Formon road, 18.31334°N, 74.01174°W, *J.D. Skean, Jr. 5039* (FLAS, NY); S edge of Ravine Seche above region called Ravine Casco ca. 0.5 km uphill from the waterfall, 18.33519°N, 74.01248°W, 9 Jan 2013, *J.D. Skean, Jr. 5043* (FLAS, NY).

+ **Meriania ekmanii** Urb.; large shrub to 4.5 m tall, occasional; rak bwa in moist, broadleaf forest or cloud forest dominated by *Pinus occidentalis* Sw., *Gleichenia bifida* (Willd.) Spreng., and *G. revoluta* H.B.K., associated with *Alsophila* sp., *Blechnum* sp., *Brunellia comocladifolia* Bonpl., *Didymopanax tremulum* Krug & Urb., and *Weinmannia pinnata* L.; 1170–1885 m. This species is a new record for Parc National Pic Macaya and was previously known only from the type specimen.

Voucher specimens: **HAITI. Département du Sud:** Massif de la Hotte, Parc National Pic Macaya, along the saddle from Morne Formon to Pic Macaya and at the base of trail leading to Pic Macaya, 18.379223°N, 74.027207°W, 12 Jan 2013, *L.C. Majure 4299* (FLAS, NY; Fig. 1); Pic Le Ciel, 18.35512°N, 74.01967°W 12 Jan 2013, *J.D. Skean, Jr. 5054* (FLAS); rak bwa between Ville Formon and Experiment Station on Deron Plain, 14 Nov 1989, W.S. *Judd 5852* (FLAS).

+ **Miconia** sp. This taxon was erroneously reported in Judd (1987) as "*Pachyanthus hotteana,*" an unpublished name, based on the collections *Judd 3939* and *Skean 2080.* It was recollected (*Ionta 2023,* FLAS) on our 2013 trip and is currently under study.

Voucher specimens: **HAITI. Département du Sud:** Massif de la Hotte, Parc National Pic Macaya, Bwa Formon, disturbed rak bwa just S of Ville Formon, 18.31483°N, 74.00946°W, 8 Jan 2013, *G.M. Ionta 2023* (FLAS, NY); Bwa Formon, moist forest on limestone (rak bwa) on hills in vicinity of Ville Formon, 1 Feb 1984, *W.S. Judd 3939* (FLAS); disturbed raw bwa ca. 0.5 km on the Morne Formon side of Sou Bwa (trail between Ville Formon & Sou Bwa), 1 Jan 1987, *J.D. Skean, Jr. 2080* (FLAS).

+ **Miconia barkeri** Urb. & Ekman. While preparing specimens of this species (of sect. *Chaenopleura*; see Judd 2007) during the January 2013 collecting trip, a distinct odor of cinnamon emanating from the leaves and inflorescences was noted during the drying process. We subsequently detected a faint cinnamon odor on previously collected herbarium material of this species housed at FLAS. Thus we report this curious finding, which has not been previously noted.

Voucher specimens: **HAITI. Département du Sud:** Massif de la Hotte, Parc National Pic Macaya, along trail of Morne Formon, Pic Formon, 18.35798°N, 74.02677°W, 11 Jan 2013, *G.M. Ionta 2028* (FLAS, NY). Additional specimens from the Parc National Pic Macaya are cited in Judd (2007).

Fig. 1. **A)** fruiting branch of *Meriania ekmanii* (*Majure 4299*), **B–C)** habit, immature fruit, and flowers of *Miconia barkeri* (*Ionta 2028*). Photos A and C taken by G.M. Ionta and B taken by L.C. Majure.

+ Miconia cordieri Ionta & Judd; shrub to 1.5 m, uncommon; in disturbed rak bwa, 950–1200 m. This recently described species (of sect. *Sagraea*; see Ionta et al. 2012) is endemic to the Macaya Biosphere Reserve (Ionta & Judd 2012). It was initially reported by Judd (1987) as *Ossaea curvipila* Urb. & Ekman (based on *W.J. Judd 3469*).

Voucher specimens: **HAITI. Département du Sud:** Massif de la Hotte: Bois Formon, S of village of Formon, S of Morne Formon, 950–1040 m, 23 Jan 1984, *W.S. Judd & D. Dod 3469* (FLAS, EHH, NY); between Ville Formon and "Experiment Station" on Deron Plain, 1170–1190 m, 14 Nov 1989, *W.S. Judd 5859* (FLAS, 2 sheets).

+ Miconia curvipila (Urb. & Ekman) Ionta, Judd, & Skean; shrub to 1.5 m, common; in disturbed rak bwa, 915–1000 m. The report of this species was based upon the specimen *Judd 3469*, which actually represents *M. cordieri*, although *Skean 1320* (see specimen cited below), which actually represents this species, was initially reported as *Ossaea setulosa* Urb., now *Miconia rubrisetulosa* Ionta, Judd & Skean (Ionta et al. 2012; Judd 1987).

Voucher specimens: **HAITI. Département du Sud:** Massif de la Hotte: karst hills just S of Sou Bwa, along road to Parc National Pic Macaya and Ville Formon. 950 m, 9 Jun 1993, *W.S. Judd 6892* (EHH, FLAS); Macaya Biosphere Reserve, Bwa Formon, disturbed "rak bwa" and fields ca. 2 km SW of home of Robert and Tila Despagne, our base camp at Ville Formon, 915–945 m, 4 Jan 1984, *J.D. Skean 1320* (EHH, FLAS); Bwa Formon, karst hills ca. 1 mi S of Ville Formon, 950-1000 m, J.D. *Skean Jr. & C. McMullen 2465* (FLAS, MICH); Between Sou Bwa and Les Platons, karst hills, 18°17'19.9"N, 73°59'28.1"W, 7 Jan 2013, *G.M. Ionta 2012* (FLAS, NY); Soulet, Between Sou Bwa and Les Platons, karst hills (disturbed rak bwa), 18.29623°N, 73.99812°W, 15 Jan 2013, *G.M. Ionta 2050* (FLAS, NY); Macaya Biosphere Reserve, Soulet, karst hills along Formon trail between Sou Bwa and Les Platons, 18.29413°N, 73.99434°W, 15 Jan 2013, *G.M. Ionta 2053* (FLAS, NY); Macaya Biosphere Reserve, Bwa Clé, disturbed rak bwa off of Formon trail, 18.28198°N, 73.98831°W, 15 Jan 2013, *G.M. Ionta 2055* (FLAS, NY); Macaya Biosphere Reserve, Soulet, karst hills along Formon trail between Sou Bwa and Les Platons, 18.29413°N, 73.99434°W, 15 Jan 2013, *L.C. Majure 4316* (FLAS, NY).

+ Miconia hottensis Ionta, Judd & Skean; shrub to 3 m, occasional; in disturbed rak bwa, 1100–1200 m. This species (of sect. *Sagraea*), endemic to the Macaya Biosphere Reserve, was recently described by Ionta et al. (2012). Until our recent collections, it was known from only two collections.

Voucher specimens: **HAITI. Département du Sud:** Massif de la Hotte: Bwa Formon, near Nan Selle at Ravine Casco, in sight of the waterfall, 1100–1200 m, 13 Aug 1989, *J.D. Skean, Jr. & C. McMullen 2557* (FLAS, JBSD, MICH, NY, S); Soulet, between Sou Bwa and Les Platons, karst hills (disturbed rak bwa), 18.29623°N, 73.99812°W, 15 Jan 2013, *G.M. Ionta 2052* (FLAS, NY).

+ Miconia navifolia Ionta, Judd & Skean; shrub to 2 m tall, occasional; in disturbed rak bwa, 1100–1200 m. This species (of sect. *Sagraea*) is an endemic to the Macaya Biosphere Reserve and was only recently described (Ionta et al. 2012). Until our recent collections, it was only known from two collections.

Voucher specimens: **HAITI. Département du Sud:** Massif de la Hotte: Macaya Biosphere Reserve, Bwa Formon, near Nan Selle at Ravine Casco, in sight of the waterfall, 1100 m, 11 Aug 1989, *J.D. Skean, Jr. & C. McMullen 2526* (FLAS, JBSD, MICH, NY, S: Type); ibid, 1100–1200 m, 13 Aug 1989, *J.D. Skean, Jr. & C. McMullen 2540* (FLAS, MICH); Between Sou Bwa and Les Platons, karst hills, 18°17'19.9"N, 73°59'28.1"W, 7 Jan 2013, *G.M. Ionta 2011* (FLAS, NY); Soulet, between Sou Bwa and Les Platons, karst hills (disturbed rak bwa), 18.29623°N, 73.99812°W, 15 Jan 2013, *G.M. Ionta 2051* (FLAS, NY); Soulet, karst hills along Formon trail between Sou Bwa and Les Platons, 18.29365°N, 73.99418°W, 15 Jan 2013, G.M. Ionta 2054 (FLAS, NY); Soulet, karst hills along Formon trail between Sou Bwa and Les Platons, 18.29365°N, 73.99418°W, 15 Jan 2013, *L.C. Majure 4317* (FLAS).

+ Miconia polychaete (Urb. & Ekman) Ionta, Judd & Skean (see Ionta et al. 2012); shrub to 1 m tall, uncommon; in disturbed rak bwa, 1017–1100 m. This species (of sect. *Sagraea*) is a new record for the Macaya Biosphere Reserve and previously was known only from the type specimen. Associated taxa include *Andropogon bicornis* L., *Cestrum bicolor* Urb., *Gleichenia* sp., *Lantana* sp., *Meriania brevipedunculata* Judd & Skean, *Miconia pyramidalis*, *M. subcompressa*, *Ocotea* sp., *Paspalum* sp., *Smilax havanensis*, *Tabebuia berteri*, and *Vernonia saepium* Ekm.

Voucher specimens: **HAITI. Département du Sud:** Massif de la Hotte: Macaya Biosphere Reserve, Bwa Formon, N slopes of Ravine Casco, in view of the waterfall, 1017 m; 18.32969°N, 74.00246°W, 9 Jan 2013, *G.M. Ionta 2025* (FLAS, NY); near Nan Selle at Ravine Casco, in sight of the waterfall, 1100 m, 11 Aug 1989, *J.D. Skean, Jr. & C. McMullen 2727* (FLAS, MICH, NY).

Myrtaceae

+ Calyptrogenia ekmanii (Urb.) Burret; small tree to 3 m tall with purple-black fruits, uncommon, 1185 m. This species is a new record for Parc National Pic Macaya.

Voucher specimens: **HAITI. Département du Sud:** Massif de la Hotte, Parc National Pic Macaya, Deron Plain; rak bwa above/behind Kay Michele Aubrey "Experiment Station," 18.33143°N, 74.00317°W, 14 Jan 2013, *J.D. Skean, Jr. 5061* (FLAS, NY).

+ **Hottea torbeciana** Urb. & Ekman; shrub, to 2 m tall, uncommon, ca. 1200 m. This species is a new record for Parc National Pic Macaya.

Voucher specimens: **HAITI. Département du Sud:** Massif de la Hotte, Parc National Pic Macaya, Deron Plain; rak bwa above/behind Kay Michele Aubrey "Experiment Station," 18.33143°N, 74.00317°W, 14 Jan 2013, *G.M. Ionta 2047* (FLAS, NY).

Poaceae

Dichanthelium aff. **dichotomum** (L.) Gould; herb, rare; forming small colonies in disturbed limestone soils (from landslide) along the edge of forest dominated by *Pinus occidentalis*, and associated with *Miconia umbellata, Pilea microphylla* (L.) Liebm., 1466 m. *Dichanthelium* was not previously recorded for Parc National Pic Macaya. This collection is not typical of *D. dichotomum* due to its densely pubescent leaf surfaces and sheaths, small leaves (0.7–1.5 × 0.09–0.27 cm), lack of a basal rosette and spreading, colonial growth form.

Voucher specimen: **HAITI. Département du Sud:** Massif de la Hotte, Parc National Pic Macaya, S slopes of Morne Formon, just N of spring, Pic Le Ciel, 18.34651°N, 74.02151°W, 10 Jan 2013, *L.C. Majure 4310* (FLAS).

Polygalaceae

* **Badiera subrhombifolia** Abbott; shrub to small tree to 7 m; in rak bwa, common, 950–1050 m. Previously reported by Judd (1987) as *Polygala penaea* L.; the populations of *P. penaea*-like plants occurring in the Macaya Biosphere Reserve, the Massif de la Selle, and the Sierra de Bahoruco have been segregated and described as *Badiera subrhombifolia* (Abbott & Judd 2011).

Voucher specimens: see Abbott and Judd (2011).

Schisandraceae

+ **Illicium hottense** A. Guerrero, Judd & A.B. Morris (Fig. 2); shrub to small tree to 4 m, common; in rak bwa and moist forests of *Pinus occidentalis*, long unburned, showing transition to cloud forest, 750–1560 m. Previously reported by Judd (1987) as *Illicium ekmanii* A.C. Smith, but the populations of *Illicium ekmanii* in the Massif de la Hotte have been segregated and described as *I. hottense* (Guerrero et al. 2004). DNA sequence data supports the sister-group relationship of *Illicium hottense* and *I. ekmanii* A.C. Smith, the latter a species occurring in the Massif du Nord, Haiti, and the Cordillera Central and Cordillera Septentrional of the Dominican Republic (Guerrero et al. 2004). *Illicium* has also been collected in the Massif de la Selle (*Ekman H2230* (S), from Morne l'Hopital, the type of *I. ekmanii* subsp. *selleanum* Imkhanitskaya); however, the specimen *Ekman H2230* has no flowers (although fruits are present) and therefore cannot be identified with certainty. It is the most papillate of all Hispaniolan *Illicium* – having papillate stems and young petioles and even fruiting pedicels. *Ekman H2230* may represent an undescribed species related to *Illicium hottense*, but flowering material is required for a definitive conclusion.

Voucher specimens: **HAITI. Département du Sud:** Massif de la Hotte, Parc National Pic Macaya, Bwa Formon, rak bwa just S of Ville Formon, 18°19'43.2"N, 73°59'41.5"W, 8 Jan 2013, *L.C. Majure 4280* (FLAS, NY); see also Guerrero et al. (2004).

Solanaceae

Acnistus arborescens (L.) Schlecht.; shrub to 2 m tall, rare; rocky (limestone) soils along ephemeral stream, associated with, *Gyrotaenia myriocarpa* Griseb., *Lobelia robusta* Graham, *Senecio stenodon* Urb., *Tibouchina longifolia* (Vahl) Baill., and *Thelypteris* sp.; ca. 1400 m. Hunziker (1982) considered the genus *Acnistus* to be monotypic consisting only of *A. arborescens*, which is widespread throughout the Neotropics. Smith and Baum (2008) showed that *A. arborescens* is deeply nested, however, within the genus *Iochroma*, and they discussed the lack of morphological characters to separate the two genera. Although the phylogenetic analysis of Smith and Baum (2008) indicated that *Iochroma* is not monophyletic, they recovered two clades, one of which contained the type species for the genus, *I. cyanea*. *Acnistus arborescens* is nested within the clade containing the type of the genus; however, *Acnistus* is the older name, thus a proposal for the conservation of the species-rich and horticulturally important genus *Iochroma* is necessary before the nomenclatural transfer can be made.

Fig. 2. A) Flower, and B) fruiting branch of *Illicium hottense*. Photos taken by L.C. Majure.

Voucher specimens: **HAITI. Département du Sud:** Massif de la Hotte, Parc National Pic Macaya, S slopes of Morne Formon, above Ravine Fond Bleu; N of Ville Formon, 11 Nov 1989, *W.S. Judd 5748* (FLAS); S slopes of Morne Formon, ravine leading to Morne Formon Trail, along ephemeral stream, 18.34201°N, 74.02126°W, 13 Jan 2013, *L.C. Majure 4302* (FLAS, NY).

+ Cestrum hotteanum Urb. & Ekman; shrub to 1 m tall, common, 933 m. Material originally identified as *C. hotteanum* from the Pic Macaya Reserve (see Judd, 1987) is referable to *Acnistus arborescens* (i.e., *W.S. Judd 5748*). Thus *C. hotteanum* is reported here for the first time from Parc National Pic Macaya.

Voucher specimen: **HAITI. Département du Sud:** Massif de la Hotte, Parc National Pic Macaya, Bwa Formon, rak bwa just S of Ville Formon, 18°19'43.2"N, 73°59'41.5"W, 8 Jan 2013, *G.M. Ionta 2022* (FLAS).

Urticaceae

The genus *Pilea*, the largest in the Urticaceae, comprises ca. 715 species (Monro 2004) of which approximately 235 occur in the Neotropics (Monro 2006). The Greater Antilles is one of the major centers of diversity of the clade (Monro 2009). *Pilea* is especially diverse on Hispaniola, with nearly 100 species found there (Liogier 1996; Moscoso 1943). To date, 14 species of *Pilea* have been recorded in Parc National Pic Macaya (Judd 1987), including *P. howardiana*, a species described by Skean and Judd (1988) and the *P. microphylla* complex, which forms a group of closely related species/entities, that is in need of further taxonomic work (see below). Additionally, previously unidentified specimens (listed as *Pilea* sp. In Judd 1987) have been found to represent a new species, which is described below.

Pilea aff. **microphylla** (L.) Liebm.—*W.S. Judd 3624* (FLAS); *J.D. Skean, Jr. 1530* (EHH). These collections were reported under this name in Judd (1987). We note that they differ from the widespread and variable *P. microphylla* in lacking small axillary branches along the major stems and in having elongate cystoliths on the adaxial leaf surface that are arranged both longitudinally and transversely; typical material of *P. microphylla* has cysto-

liths that are exclusively transversely oriented (i.e., oriented at right angles to the leaf axis). These specimens are extremely succulent, while typical material of *P. microphylla* has leaves that vary from nearly herbaceous to extremely succulent. We also note that the leaves of these specimens are not spathulate, as in the phenetically similar *P. spathulifolia* Groult of the Sierra de Bahoruco, in the Dominican Republic (Groult 1999).

Voucher specimens: **HAITI. Département du Sud:** Massif de la Hotte, Macaya Biosphere Reserve, S slopes of Morne Formon, N of Ville Formon, 1670–1770 m, 25 Jan 1984, *W.S. Judd 3624* (FLAS); S slopes of Morne Formon, along trail leading from the cirque to the ridge, 1525–1830 m, 11 Jun 1984, *J.D. Skean, Jr. 1530* (EHH).

+ **Pilea vermicularis** Majure, Skean & Judd, sp. nov. (**Fig. 3**). Type: HAITI. Département du Sud: Massif de la Hotte, Macaya Biosphere Reserve, extremely disturbed fields between Ville Formon and S slopes of Morne Formon, along trail leading to the cirque and above, along N-facing slopes SW of Ravine Seche, 1000–1220 m, 10 Jun 1984, *J.D. Skean, Jr. 1500* (holotype: FLAS!, isotypes: FLAS!, NY!).

Species haec a Pilea wullschlaegelii Urb. differ caulibus pubescentibus (non glaberis). Pagina abaxiali foliorum sine hydathodes, et base acutata (non obtusata vel rotundata).

Shrubs, apparently dioecious, woody, to 60 cm tall, highly branched; indumentum of simple, ± flattened, silvery, multicellular hairs; young stems rectangular in cross section with filiform cystoliths parallel to the stem axis 0.1–0.3 mm long, pubescent with clear, multicellular, uniseriate, ascending hairs to 0.3 mm long; stems becoming rounded in cross section and glabrous in age, 0.4–1.6 mm in diameter; leaves opposite, decussate, moderately anisophyllous, i.e., the smaller leaf ½ to ¾ the size of the larger leaf, to isophyllous, 0.45–1.7 × 0.25–0.9 cm, ovate to elliptic, the apex acute, the base acute to obtuse, serrate along distal ⅔ or more of the leaf margin, mostly entire at base, each serration with a single vein, glabrous on both surfaces or with sparse, multicellular hairs to 0.5 mm long on the primary vein of the abaxial leaf surface, 3-veined, but with secondary veins brochidodromous in distal portion of lamina, primary and secondary veins impressed adaxially and raised abaxially, veins on the abaxial leaf surface with conspicuous filiform cystoliths produced parallel to the vein axis, adaxial leaf surface covered in dense, conspicuous, oblong to filiform cystoliths 0.3–0.4 × 0.05–0.1 mm, produced in all directions (i.e., disorganized) and oftentimes overlapping, and becoming smaller toward the center of the lamina, abaxial leaf lamina with punctiform to filiform, inconspicuous cystoliths, petioles 0.9–5.5 mm long, pubescent on the adaxial surface, hairs erect to ascending, glabrous on the abaxial surface although with conspicuous punctate to elongate cystoliths; intrapetiolar stipules 1.3–2.8 × 1.2–1.7 mm, obovate to oblong, apices truncate, rounded or slightly 3-lobed, with conspicuous filiform cystoliths produced parallel to the axis on the abaxial surface; carpellate inflorescences red, producing ± cymose clusters of flowers along the main axis, 0.6–1.2 cm long, 0.15–0.8 cm across, bracts 0.3–0.6 × 0.05 mm, ovate to obovate with apices acute, rounded or three-lobed as in the stipules; carpellate flowers with pedicels 0.3–0.4 mm long, tepals 3, dimorphic, the larger tepal saccate, 0.4–0.7 mm long, elliptic, forming a cup-shaped, fleshy structure enclosing gynoecium, its margins incurved, clasping, and membranous, apex 3-lobed, the central lobe succulent and exceeding the two membranous lateral lobes, the two lateral tepals 0.2–0.6 mm long, ovate to narrowly elliptic, with acute apices; ovary appearing unicarpellate, stigma penicellate, with elongated papillae; staminate flowers not seen; achenes elliptical, biconvex, brown, the surface moderately alveolate, 0.6–0.65 × ca. 0.4 mm.

Etymology.—The specific epithet *vermicularis* refers to the wormlike appearance resulting from the disorganized and oftentimes overlapping cystoliths on the adaxial leaf surface (Fig. 3D).

Putative relationships.—*Pilea vermicularis* is morphologically similar to *P. wullschlaegelii* Urb. (Jamaica) and *P. radicans* (Sw.) Wedd. (both from Jamaica); all three species have "disorganized" cystoliths associated with the adaxial leaf surface, glabrous leaf surfaces, and serrate leaves. *Pilea vermicularis* differs from these species by its pubescent stems (Fig. 3B). *Pilea vermicularis* also differs from *P. wullschlaegelii* by the lack of glands (hydathodes) on the lower leaf surface and the acute to obtuse vs. obtuse to rounded leaf bases (Fig. 3C, E, F). *Pilea vermicularis* differs from *P. radicans* by its frutescent habit (vs. vine-like habit in the latter). *Pilea vermicularis* is also similar to *P. rufescens* Fawc. & Rendle (Jamaica), although that species has densely pubescent leaves and reddish hairs on the stem, instead of glabrous leaves and silvery stem hairs. Morphologically, *P. vermicularis* appears to be closely related to Clade 2, Unit 5 of Monro (2006), sharing heteromorphic leaves

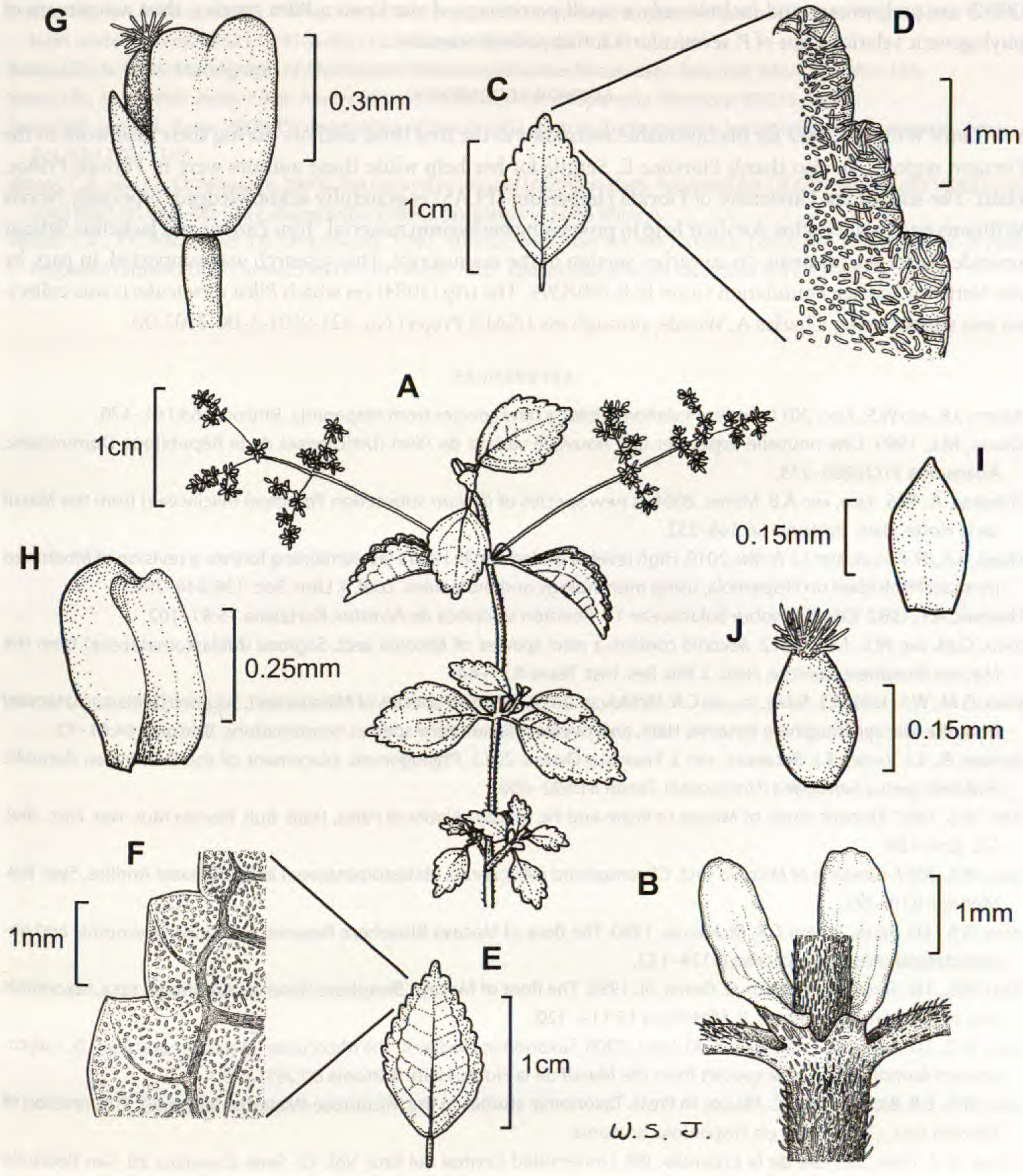

Fig. 3. Illustration of *Pilea vermicularis*. A) habit, B) close-up of stem and intrapetiolar stipules, C) leaf, adaxial surface, D) close-up of adaxial leaf surface, E) leaf, abaxial surface, F) close-up of abaxial leaf surface, G) carpellate flower, H) larger, saccate tepal, I) smaller, lateral tepal, J) achene.

with incised margins and 3-merous carpellate flowers (Fig. 3C, E, G). However, those taxa are known from Central America instead of the West Indies and are glabrous instead of pubescent. The West Indian subclade (Clade 2, Unit 4) contains pubescent species with isomorphic leaves with entire margins, and 3-merous carpellate flowers (Monro 2006; see also "Clade H" in Jestrow et al. 2012). *Pilea vermicularis* may belong to this group if leaf margins are not consistent throughout the clade. Members of this clade occur in the Parc National Pic Macaya (e.g., *P. domingensis* Urb.; Judd 1987). The phylogenetic analyses of Monro (2006) and Jestrow et al.

(2012) are preliminary and include only a small percentage of the known *Pilea* species, thus assessment of phylogenetic relationships of *P. vermicularis* at this point is tentative.

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BOOK REVIEW

George Yatskievych. 2013. **Steyermark's Flora of Missouri, Volume 3: Dicots, Fabaceae (subfamily Faboideae) through Zygophyllaceae.** (ISBN-13: 978-0-915279-13-5, hbk). Missouri Botanical Garden Press, P.O. Box 299, Saint Louis, Missouri 63166-0299, U.S.A., in cooperation with the Missouri Department of Conservation, P.O. Box 180, Jefferson City, Missouri 65201-0180, U.S.A. (**Orders:** www.mbgpress.info, orders@mbgpress.org, 1-877-271-1930). $65.00, xvii + 1382 pp., 194 plates of b&w line drawings, 20 figures (incl. 27 b&w photographs), 798 distribution maps, 7" × 10" × 2.5".

(continued from p. 680)

necessary this would be cumbersome. The same situation occurs for members of the genus *Acer* that has been moved from the Aceraceae covered in Volume 2 to the Sapindaceae covered in Volume 3. Anyone attempting to key out an unknown *Acer* spp. after reaching that genus in the Sapindaceae key must then use the key to the genus in Volume 2. Obviously, the taxonomy of plants is in a constant state of flux so the unfortunate set of circumstances involving the genus *Acer* is no fault of the author, but it would have been helpful to repeat the key to the genus in Volume 3. That, however, was likely unachievable due to scheduled deadlines.

It would have been useful to include a short discussion in the introduction on some of the more recent and divergent changes in taxonomy such as *Desmodium* to *Hylodesmum*, some *Lespedeza* to *Kummerowia*, *Psoralea* to *Orbexilum* or *Pediomelum*, *Coronilla* to *Securigera*, *Bumelia* to *Sideroxylon*, *Saxifraga* to *Micranthes*, *Dodecatheon* to *Primula*, *Hybanthus* to *Cubelium*, etc. The author does provide a short summary of some of the major familial changes in the preface to the book, but it is difficult to comprehend the magnitude of such changes without the help of a table that would list the old and new names for families, genera, and in some cases, species. There is considerable discussion on the new families that have emerged from Scrophulariaceae and genera that are now merged into this family on page 1106, but as noted above, the changes would have been best represented in a comparison table.

Some amateur botanists and naturalists are likely to have difficulty with many of the technical terms used in family, genera, and species accounts, especially those associated with molecular genetics, but the author provides a glossary in the back of the book with definitions for the overwhelming majority of sophisticated botanical language. Due to scheduling deadlines, it is unfortunate that some species are not illustrated (e.g. *Aeschynomene rudis*, *Centrosema virginianum*, *Cotoneaster acutifolius*, *Dalea gattingeri*, *D. villosa*, *Lablab purpureus*, *Lathyrus tuberosus*, *Rhodotypos scandens*, multiple species of *Rubus* spp., *Spirea japonica*, etc.). As with any botanical compilation, however, it is impossible to keep up with new additions of taxa to state floras, and the author mentions in the preface that an average of nine species are added to the Missouri flora each year. Several species of *Crataegus* have been reduced to varietal rank, but the lack of county distribution maps for the different variants prevents a visual evaluation of areas of the state where such varieties may be found or a cursory examination of the conservation status of rare taxa based on the number of counties where they have been documented. Finally, I suppose there may be a few individuals who will complain about the $65 price tag, but the book is a bargain when compared to the information provided.

Overall, the negative comments should be considered nonconsequential compared to the overall quality of the book. As with Volumes 1 and 2, Volume 3 of the *Flora of Missouri* should be on the book shelf of every botanist, naturalist, and plant enthusiast in the Midwest. No longer should the entire treatment of *Flora of Missouri*, Volumes 1, 2, and 3 by George Yatskievych be compared to his mentor's original work. With the completion of the revision, it is Yatskievych who has set the standard for similar state floras to follow!—*Paul M. McKenzie, Ph.D., U.S. Fish and Wildlife Service*, 101 Park DeVille Drive; Suite A, Columbia, Missouri 65203, U.S.A.*

*The findings and conclusions in this article are those of the author and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

CHUSQUEA CLARKIAE (POACEAE: BAMBUSOIDEAE: BAMBUSEAE: CHUSQUEINAE): A NEW SPECIES IN SECTION *LONGIPROPHYLLAE* FROM NARIÑO, COLOMBIA

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ABSTRACT

Chusquea clarkiae (Poaceae: Bambusoideae: Bambuseae: Chusqueinae), a new species in section *Longiprophyllae* from the Cordillera Occidental of Nariño, Colombia, is described and illustrated. It differs from *C. longiprophylla* (Cordillera Central and Cordillera Oriental) in its larger spikelets (8.5–10 mm long versus 7.1–8.5 mm long), and lower elevational preference of 1130 m (versus 1750–2200(–2700) m).

RESUMEN

Se describe e ilustra **Chusquea clarkiae** (Poaceae: Bambusoideae: Bambuseae: Chusqueinae), una nueva especie de la sección *Longiprophyllae* de la Cordillera Occidental de Nariño, Colombia. Se diferencia de *C. longiprophylla* (Cordillera Central y Cordillera Oriental) por tener sus espiguillas más grandes 8.5–10 mm de longitud (versus 7.1–8.5 mm de longitud), y por preferir un rango de distribución altitudinal más bajo de 1130 m (versus 1750–2200(–2700) m).

INTRODUCTION

A bamboo collected in Colombia along the Pasto to Tumaco road in 1990 by the second author, John Kress, and Wilson Devia is, upon examination, a new species of *Chusquea* Kunth (Poaceae: Bambusoideae: Bambuseae: Chusqueinae). Its combination of a scandent habit, infravaginal branching, tightly circular array of subsidiary buds, narrow, erect, persistent, abaxially scabrous culm leaf blades, spikelets with well-developed glumes I and II, and apiculate spikelet bracts all place it as a member of *Chusquea* Section *Longiprophyllae* L.G. Clark, a group that now comprises seven species occurring at elevations of (950–)1130–2750 m in the Andes from Venezuela to central Peru. The Section is most diverse in Colombia (Clark 1990).

TAXONOMY

Chusquea clarkiae Londoño & Judz., sp. nov. (**Figs. 1, 2**). Type: COLOMBIA. Nariño: Mpio. Altaquer, 10 km de Altaquer por la vía a Tumaco, junto al oleoducto del Pacífico, 1130 m, Bambú escandente, ca. 10 m altura, culmos 1–1.5 cm de diametro, ramificación compuesta por una yema central, no muy larga, y varias secundarias, con flor, 14 Sep 1990, *X. Londoño, J. Kress & W. Devia* 502 (holotype: COL; isotypes: TULV, UWSP).

Rhizomes unknown. Culms up to 10 m long, 1–1.5 cm in diameter, scandent, solid. **Culm leaves** at least 26 cm long (base not seen), sheaths at least 20 cm long, abaxially strongly retrorsely scabrous, the midrib obscure; blades 6.5–8.5 cm long (in two examples available), folded width at base 3–5 mm, linear-attenuate, erect, persistent, abaxially slightly retrorsely scabrous, the midrib inconspicuous, the margins glabrous; inner ligules 0.5–1 mm long. **Nodes** at mid-culm with a central bud subtended by 4 slightly smaller subsidiary buds; supranodal ridge visible as a slightly raised line, not prominent; girdles 1.5–2.5 mm wide, brown to dark brown, covered with fine, brown, retrorsely appressed, silky hairs 0.5–1 mm long. **Branching infravaginal,** with emergent branches in available material diverging downwards up to 30° from the main culm; prophylls 2—4 cm long, narrow, glabrous; leafy subsidiary branches 4–5 per node, 4–8 cm long, ca. 1 mm in diameter, not rebranching. **Foliage leaves** 4–7 per complement; sheaths glabrous, uniform in color, keeled toward the sum-

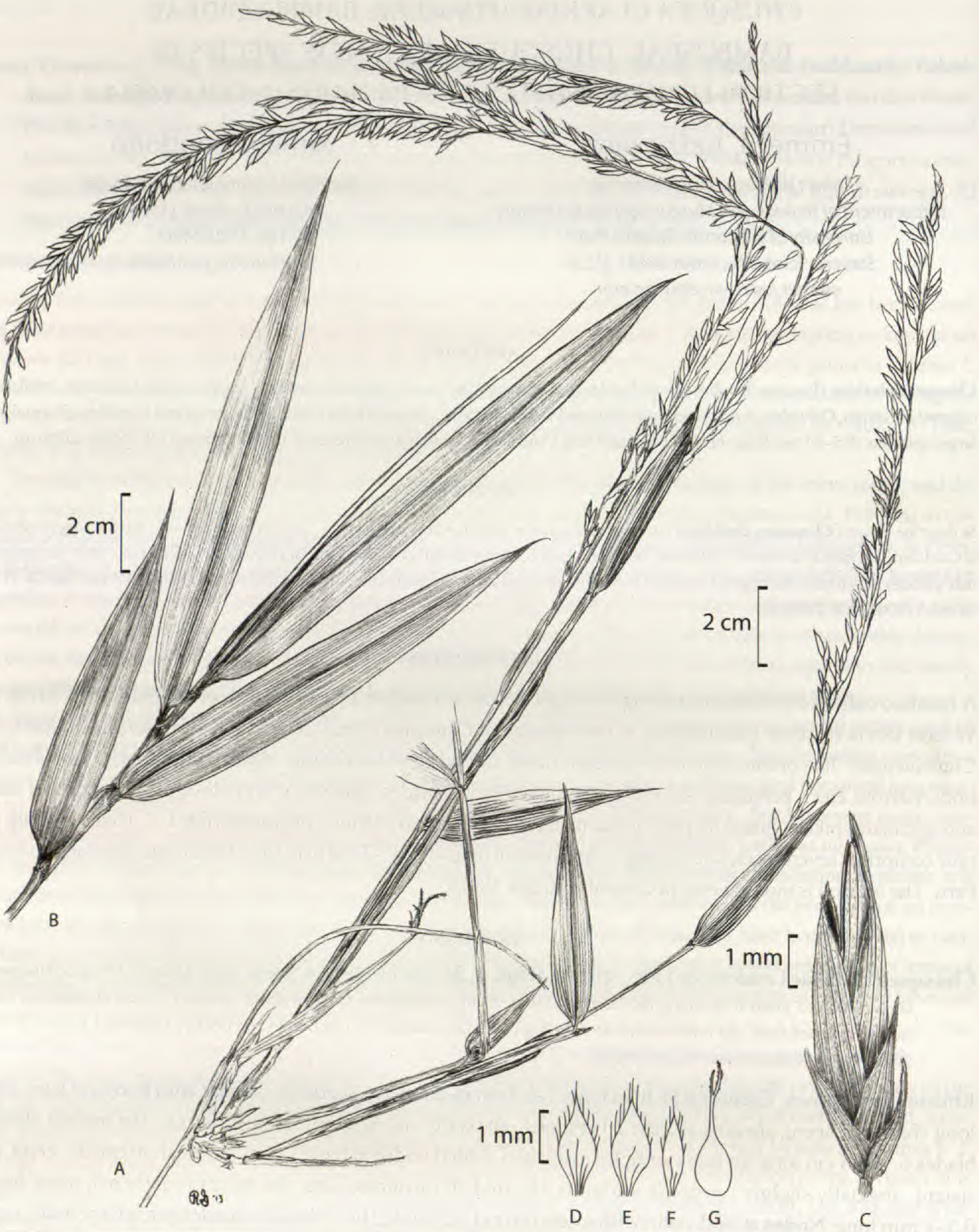

FIG. 1. ***Chusquea clarkiae*. A. Culm and branch complement with flowering branches. B. Foliage leaf complement. C. Spikelet, lateral view. D–E. Anterior lodicules. F. Posterior lodicule. G. Gynoecium. Based on *Londoño et al. 502* (UWSP). Illustration by Rebecca A. Gregory.**

mit, the margins glabrous, summit extension absent to 2 mm long; blades 13–20 cm long, 1.5–2 cm wide, L:W = 8–10, narrowly lanceolate, glabrous except puberulent on the adaxial surface of the pseudopetiole, not tessellate, the midrib usually visible abaxially and prominent for ca. ⅔ the length of the blade, the base rounded-attenuate, the apex acuminate-attenuate, the margins antrorsely scabrous to serrulate; pseudopetioles 3–5 mm long; outer ligules 1–2 mm long, indurate, usually irregularly bilobed, each lobe in turn lacerate, glabrous; in-

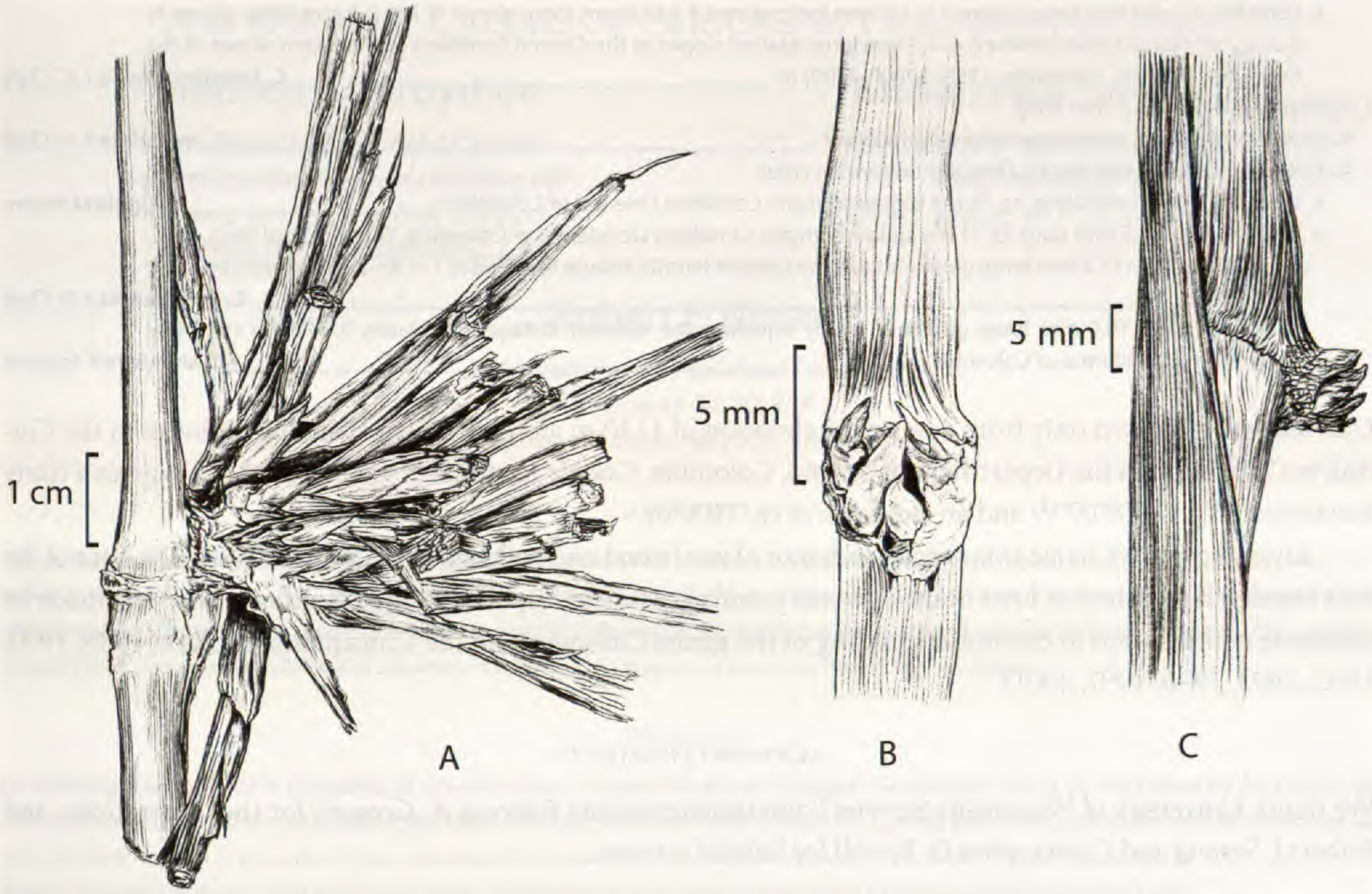

FIG. 2. *Chusquea clarkiae*. **A.** Detail of branch complement. **B.** Front view of emergent infravaginal branch complement. **C.** Lateral view of culm showing erect culm leaf (left) and emergent infravaginal branch complement. Based on *Londoño et al. 502* (UWSP). Illustration by Rebecca A. Gregory.

ner ligules 7–12 mm long, narrowly triangular, firmly membranous, glabrous. **Inflorescences** 23–30 cm long, 1.5–2.5 cm wide, narrowly paniculate, the rachis angular and puberulent, the branches angular, glabrous, ridged, and scabrid, the lowermost branches 2.5–6.5 cm long, ascending at maturity, the secondary and higher order branches erect, the pedicels 2–4 mm long, angular, appressed to the branches. **Spikelets** 8.5–10 mm long, puberulent with retrorse hairs ca. 0.1 mm long, more or less dorsally compressed; glume I 2–4.5 mm long, 1–5(–7)-nerved, acuminate; glume II 3–5 mm long, 3–7(–9)-nerved, acuminate to somewhat apiculate; glume III 5–6.5 mm long, (5–)7–9(–11)-nerved, acuminate-apiculate to somewhat navicular; glume IV 7.5–9 mm long, (7–)9–11(–13)-nerved, navicular; lemma 8.5–10 mm long, 9–11-nerved, navicular; palea 8–9.5 mm long, shorter than the lemma, biapiculate, glabrous, 4-nerved, sulcate for nearly its full length, puberulent near apex. Lodicules 3, apically ciliate with erect hairs 0.3–0.4 mm long; anterior pair 1.7–2 mm long, the posterior one 1.3–1.7 mm long. Stamens 3, the anthers 3.5–4.5 mm long. Gynoecium with ovary ovoid, glabrous, 1 mm long, the style ca. 0.8 mm long, the stigmas 2, 0.5–0.7 mm long, short-plumose. **Fruit** not seen.

Following the key to species of Section *Longiprophyllae* for both vegetative and flowering material in Clark (1990:626–627), this collection would be identified as *C. longiprophylla* L.G. Clark; however, *C. longiprophylla* is from the central and eastern cordilleras of Colombia, found at somewhat higher elevations (1750–2200 (–2700) m) than *Londoño et al. 502* and has smaller spikelets and glumes. On the basis of these characters and distribution, we recognize the new species *C. clarkiae*. Clark's 1990 key to Section *Longiprophyllae* may be revised to accommodate *C. clarkiae* as follows:

1. Spikelets 7.1–10 mm long.
   2. Foliage leaf blades 0.3–0.8 cm wide ______ **C. londoniae** L.G. Clark
   2. Foliage leaf blades 1–2.4 cm wide.
      3. Spikelets 8.5–10 mm long; glume I 2–4.5 mm long; glume II 3–5 mm long; glume III 5–6.5 mm long; glume IV 7.5–9 mm long; fertile lemma 8.5–10 mm long; southern Cordillera Occidental, Colombia, 1130 m ______ **C. clarkiae** Londoño & Judz.

3. Spikelets 7.1–8.5 mm long; glume I 1–1.2 mm long; glume II 1.6–3 mm long; glume III 2.9–3.2 mm long; glume IV 5.2–6.2 mm long; fertile lemma 6.4–7.5 mm long; eastern slopes of the Central Cordillera and western slopes of the Cordillera Oriental, Colombia, 1750–2200(–2700) m ____ **C. longiprophylla** L.G. Clark
1. Spikelets (8.8–)10–13.3 mm long.
 4. Spikelets glabrous; culm leaves abaxially mottled ____ **C. maculata** L.G. Clark
 4. Spikelets scabrid; culm leaves abaxially uniform in color.
  5. Glume III 5.9–8.7 mm long, ca. ¾ the spikelet length; Cordillera Oriental of Colombia ____ **C. ligulata** Munro
  5. Glume III I 4.1–5.5 mm long, ca. ½ the spikelet length; Cordillera Occidental of Colombia, Ecuador, and Peru.
   6. Spikelets 10.7–11.3 mm long; glume IV ca. 4 the spikelet length; foliage leaf blades 1–1.4(–2.1) cm wide; Ecuador and Peru ____ **C. exasperata** L.G. Clark
   6. Spikelets 9.8–10.9 mm long; glume IV nearly equaling the spikelet; foliage leaf blades 0.6–1(1.3) cm wide; Cordillera Occidental of Colombia ____ **C. sneidernii** Asplund

Distribution.—Known only from a recorded elevation of 1130 m along the Pasto-Tumaco highway in the Cordillera Occidental in the Department of Nariño, Colombia. Google Earth (accessed 18 June 2013) gives a likely location of 1°19'N, 78°07'W and an elevation of ca. 1100 m.

Etymology.—We name this species in honor of our friend and colleague Dr. Lynn G. Clark, Director of the Ada Hayden Herbarium at Iowa State University, and agrostologist specializing in bamboos, who has made an immense contribution to our understanding of the genus *Chusquea* and the Chusqueinae (Clark, 1989, 1990, 1992, 1993, 1996, 1997, 2001).

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THE SPIKELET CALLUS OF *ERIOCHLOA VILLOSA* (POACEAE)

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ABSTRACT

The spikelet callus morphology of *Eriochloa villosa* (Thunb.) Kunth is examined and compared with that in other species of the genus. The callus is divided into two parts, a lower hardened bead and an upper fleshy cup. The cup possesses a membranous ventral projection which often surpasses the cup apex. Epidermal characteristics of the callus are similar to those of most other species in the genus. The cup and ventral projection contain substantial amounts of lipids which may act to attract animal dispersal agents.

RESUMEN

La morfología del callo de la espiguilla de *Eriochloa villosa* (Thunb.) Kunth se examinó y se comparó con la de otras especies del género. El callo se divide en dos partes, una endurecida, talón inferior, y una taza carnosa superior. La copa posee una proyección ventral membranosa que a menudo supera el ápice de la taza. Las características epidérmicas de los callos son similares a los de la mayoría de otras especies del género. La copa y la proyección ventral contienen lípidos que pueden actuar para atraer a agentes animales de dispersión.

INTRODUCTION

The panicoid grass genus *Eriochloa* contains about 30–35, primarily tropical and subtropical, species which are characterized by an unusual swelling and cup-like callus structure at the base of the spikelets (Clayton & Renvoise 1986). This unusual structure has been interpreted as a swelling of the lowest rachilla internode surmounted by the lower (proximal) glume which is reduced to a short flange of tissue (Hsu 1965; Shaw & Smeins 1979, 1983). However, in their anatomical examination of the callus of three *Eriochloa* species, Thompson et al. (1990) found that the stele in the spikelet rachis remained unbranched until the upper glume traces, and interpreted the lack of stelar nodes within the callus region as an indication that no part of the callus is likely to represent a vestigial lower glume. Although the callus structure has been investigated in a number of *Eriochloa* species, it has not been studied in *E. villosa* (Thunb.) Kunth. This species is native to eastern Asia from the Russian Far East to northern Viet Nam, but has been introduced to other areas including North America where it has been spreading as an agricultural weed (Darbyshire et al. 2003).

Shaw and Smeins (1979, 1983) examined epidermal characteristics of the spikelet callus in 20 species of *Eriochloa*. They observed that the structure was divided into two parts, both with characteristics of the epidermis consistent with the interpretation that the callus is formed from an expansion of the lowest rachilla internode and surmounted by the remnants of the first glume. Three types of calluses were described (Table 1). The Type 1 callus was by far the most common in the genus, being seen in 16 of the species examined (*E. aristata* Vasey, *E. boxiana* Hitchc., *E. contracta* Hitchc., *E. eggersii* Hitchc., *E. ekmanii* Hitchc., *E. acuminata* (J. Presl) Kunth (= *E. lemmonii* var. *gracilis* (E. Fourn.) Gould), *E. lemmonii* Vasey & Scribn., *E. meyeriana* (Nees) Pilger, *E. michauxii* (Poir.) Hitchc., *E. montevidensis* Griseb., *E. pacifica* Mez, *E. peruviana* Mez, *E. punctata* (L.) Ham., *E. sericea* (Scheele) Vasey, *E. setosa* (A. Rich.) Hitchc., and *E. weberbaueri* Mez). Distinctive features of the Type 1 callus included a basal portion with a smooth epidermis beset with silica bodies and an apical portion of plicate epidermal tissue. The Type 2 callus, seen in 3 species (*E. distachya* Kunth, *E. grandiflora* (Trin.) Benth.

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TABLE 1. Comparison of *Eriochloa* callus characteristics described by Shaw and Smeins (1979) with those observed on *E. villosa*.

Character	Callus Type 1	Callus Type 2	Callus Type 3	*E. villosa*
bead texture	smooth	smooth	"roughened mosaic"	smooth
bead epidermis	smooth	smooth	rough	smooth to minutely roughened
bead macrohairs	absent	absent	absent	present; occasional
bead microhairs	absent	absent	absent	present (distal part)
bead stomata	absent	absent	absent	absent
bead silica bodies	present; bilobed and tetralobed	absent	absent	present (proximal part); rounded, elliptical or weakly lobed
cup texture	heavily plicate	heavily plicate	lightly plicate	heavily plicate
cup macrohairs	absent	absent	absent	present; occasional
cup microhairs	present	absent	present	present
cup stomata	absent	absent	absent	absent
cup silica bodies	absent	absent	present; trilobate, tetralobate	absent

and *E. nelsonii* Scribn. & J.G. Sm.), was similar to Type 1 but larger in size and lacking silica bodies. The Type 3 callus, seen in only one New World species (*E. polystachya* Kunth), had the basal portion without a smooth and indurate epidermis and the apical portion was a membranous "reduced glume" encircling the base of the spikelet. The Old World species *E. rovumensis* (Pilg.) Clayton (= *E. biglumis* Clayton) is somewhat anomalous in the genus, possessing a swollen spikelet base and well-developed lower glume, although Shaw and Smeins (1983) state that the lower glume is similar to that seen in *E. polystachya*.

The purpose of this study was to examine the characteristics of the spikelet callus in the Asian *E. villosa* and compare it with the previously published observations on other species which are primarily from North and South America and Africa.

MATERIALS AND METHODS

Spikelets originating from populations occurring in southern Quebec (Darbyshire et al. 2003) were used. Thirty randomly selected spikelets from one population were measured under 10× magnification for spikelet and callus size and the measurements were compared with those given by Shaw and Smeins (1979). Selected spikelets were air-dried, coated with gold and examined with a Philips XL30 ESEM microscope at 5kV acceleration voltage. Spikelets stored in 70% ethanol were re-hydrated, hand sectioned and stained with methylene blue or toluidine blue O. Air-dried spikelets were re-hydrated, hand sectioned and stained with Sudan IV.

RESULTS AND DISCUSSION

Spikelets are broadly elliptical and dorsiventrally compressed (Fig. 1 A). The size is reported as 3.9–5.5(–6.5) mm long, 2.0–2.8(–3.0) mm wide (Darbyshire et al. 2003; Shaw et al. 2003). Spikelets from the Quebec population measured 5.3 (SD = 0.18) mm long and 2.7 (SD = 0.09) mm wide, with the callus 0.8 (SD = 0.09) mm long and 1.5 (SD = 0.12) mm wide. The observed *E. villosa* callus size was larger than in any of the 19 species examined by Shaw and Smeins (1979). The callus length and width averaged 15% and 55% of the spikelet length and width, respectively. Shaw and Smeins (1979) reported variation in callus sizes between species they measured, with Type 2 calluses tending to be larger than Type 1, but no correlation between callus size (length/width) and type was detected in this study (data not shown). Epidermal characteristics of the callus of *E. villosa* are most similar to those described as Type 1 by Shaw and Smeins (1979).

Apart from the central bundles, no branching of vascular tissue was observed anywhere in the callus structure (cf. Thompson et al. 1990). The callus was divided into two more or less equal and strongly demarcated parts (Fig. 1). The basal part (bead) is formed of hardened tissues and the apical portion (cup) above is fleshy. The cup of the callus usually did not form a complete ring thereby incompletely clasping the spikelet (Fig. 1 B), although sometimes the cup was almost completely encircling with only a small notch at the junction

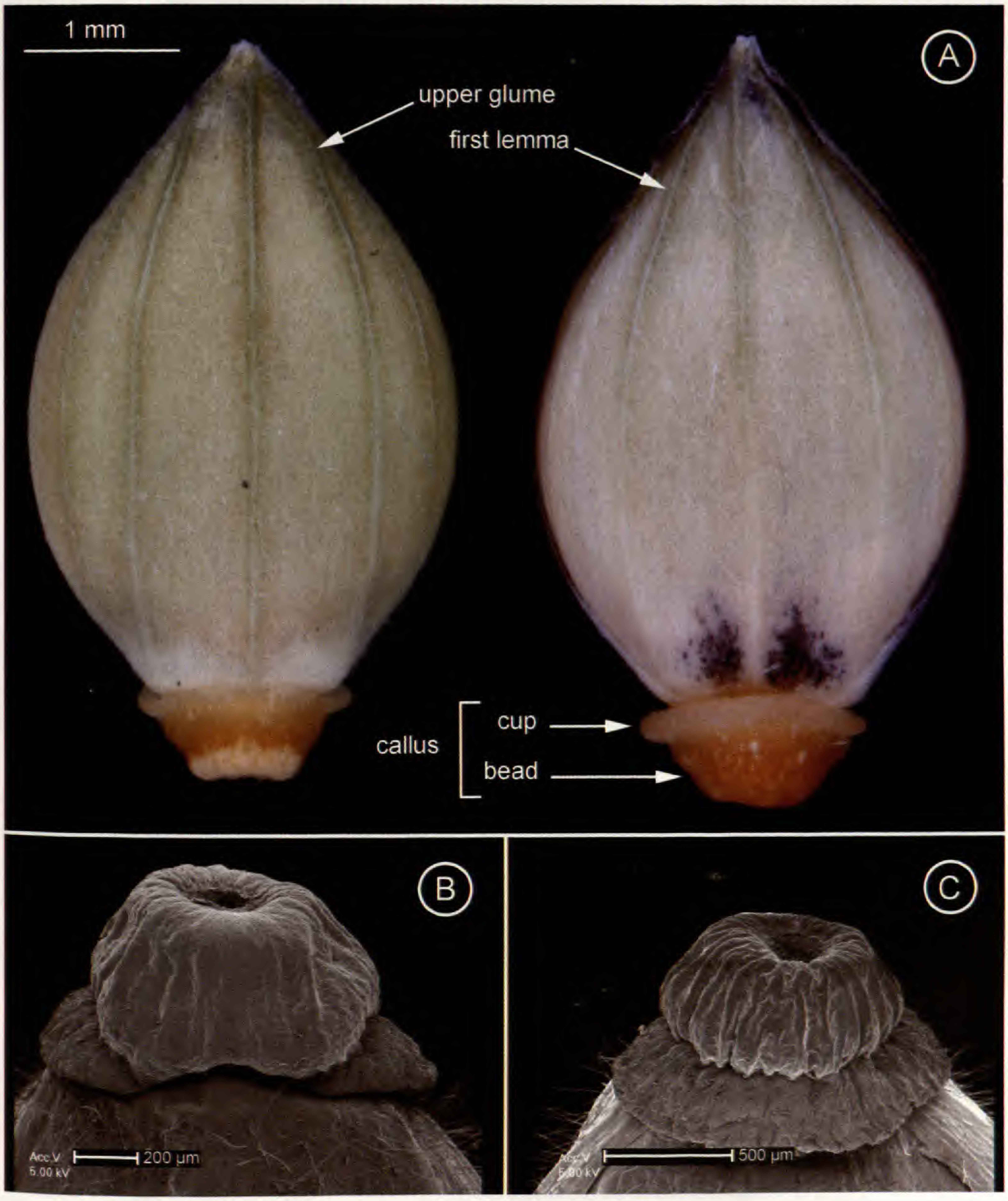

Fig. 1. Spikelets of *Eriochloa villosa*. A, left adaxial view, right abaxial view (light); B, adaxial view of spikelet callus (SEM); C, abaxial view of spikelet callus (SEM).

of the lateral edges (Fig. 1 A, left). The callus cup was directly opposite the upper glume or only slightly off centre (i.e., not quite bilaterally symmetrical). An additional flap of tissue arising from the adaxial surface of the callus cup is present in some species of *Eriochloa* and was referred to as an "extension" by Shaw and Smeins (1979) and as a "ventral projection" by Thompson et al. (1990). The ventral projection in the callus of *E. villosa* was observed to arise from the adaxial side of the cup at its base, where it formed a second inner, but incomplete

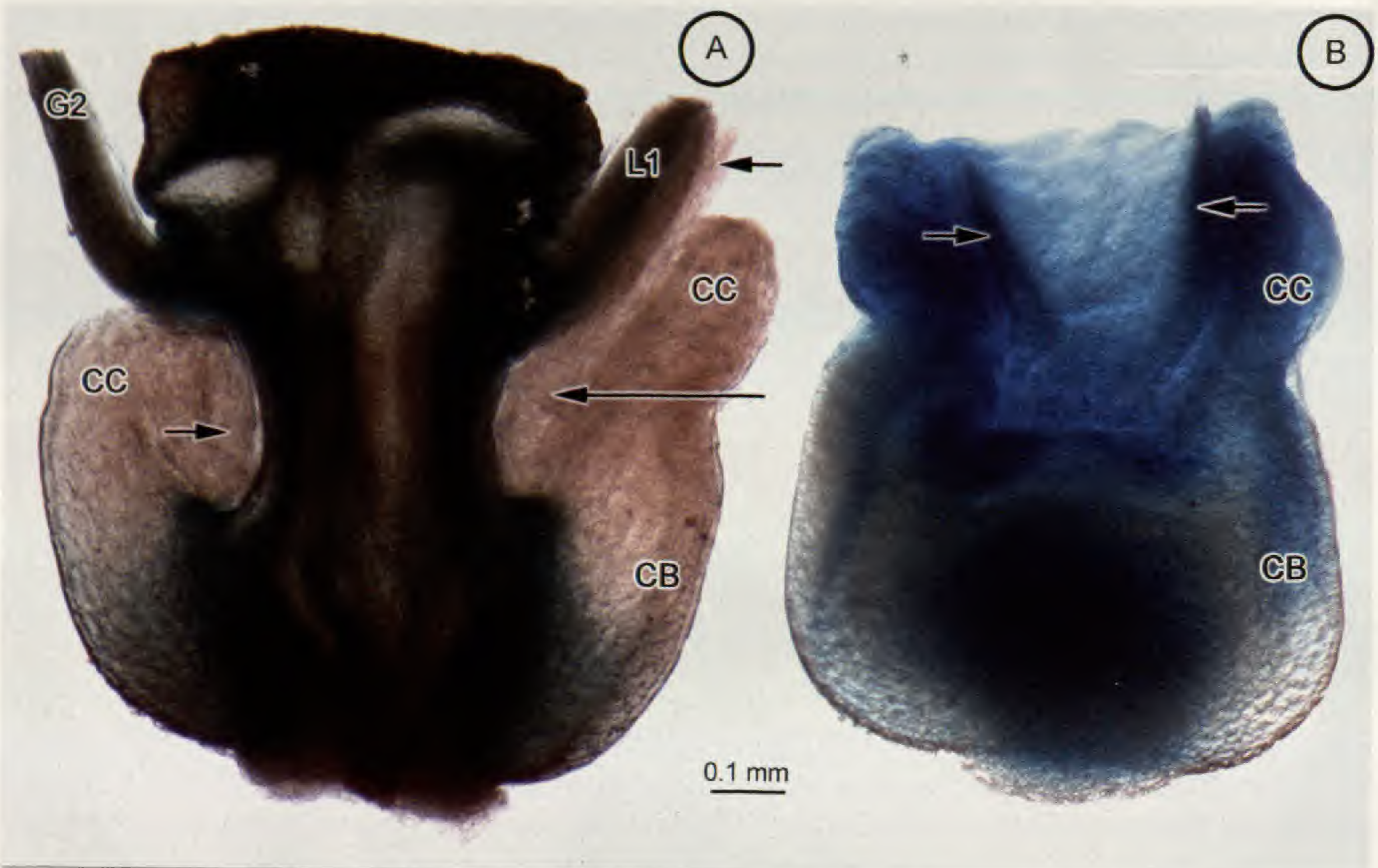

Fig. 2. Spikelet callus of *Eriochloa villosa*. **A**, longitudinal section (approximately medial) stained with toluidine blue O showing poorly stained ventral projection (arrows) extending beyond callus cup in the central region (abaxial side on the right) and reduced in the marginal region (adaxial side on the left); **B**, tangential plane section stained with methylene blue showing ventral projection (arrows). CB = callus bead; CC = callus cup; G2 = upper glume; L1 = lower lemma.

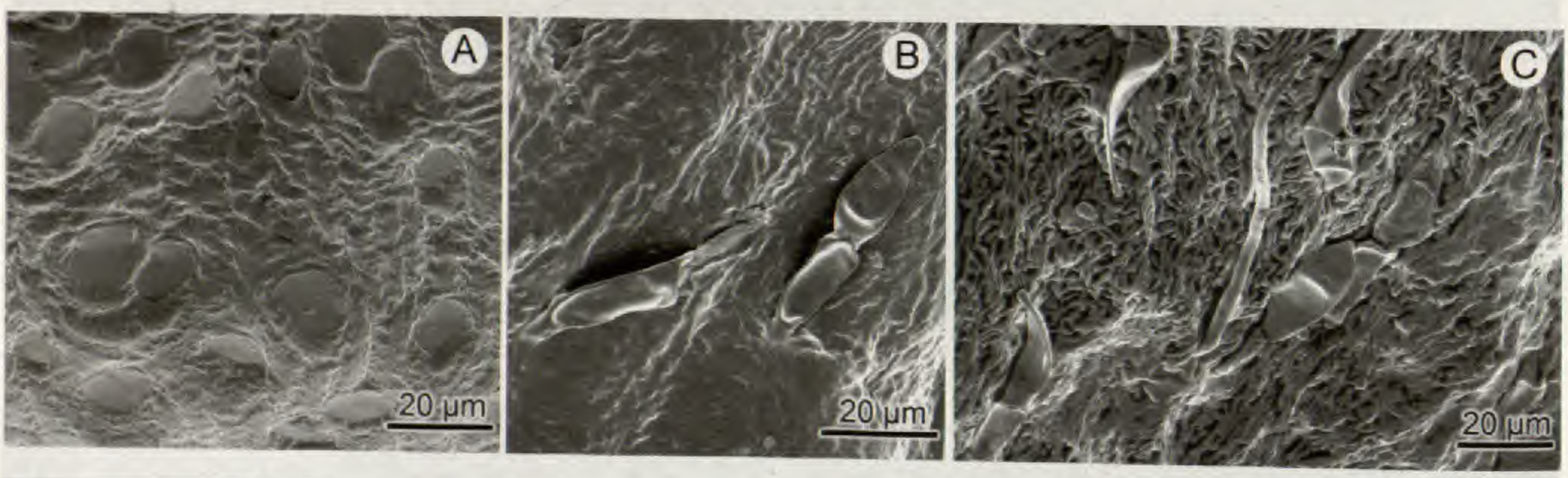

Fig. 3. Scanning electron micrographs of *Eriochloa villosa* spikelet callus. **A**, proximal callus bead showing rounded silica bodies; **B**, distal callus bead showing bicellular microhairs; **C**, callus cup showing plicate epidermis, a single macrohair (center) and several bicellular microhairs.

membranous cup (Fig. 2 A, B). Sometimes the ventral projection extended beyond the fleshy portion of the cup (Fig. 1 A (right), 2 A), but usually this flange of tissue was not visible without dissection (Fig. 2 B, 4). The position of the ventral projection is consistent with the position of the first glume, although there is no other evidence of homology.

No stomata or prickle hairs were observed on either part of the *E. villosa* callus. The bead epidermis was hardened and smooth or minutely roughened (Fig. 3 A, B). Bicellular microhairs were common apically (Fig. 3 B), but macrohairs were rarely seen. Rounded to broadly eliptic or shallowly lobed silica cells were common basally (Fig. 3 A). The abaxial epidermis of the cup was heavily plicate (Fig. 3 C). Silica bodies were not observed on the cup. Bicellular microhairs were common throughout the cup and macrohairs were occasionally

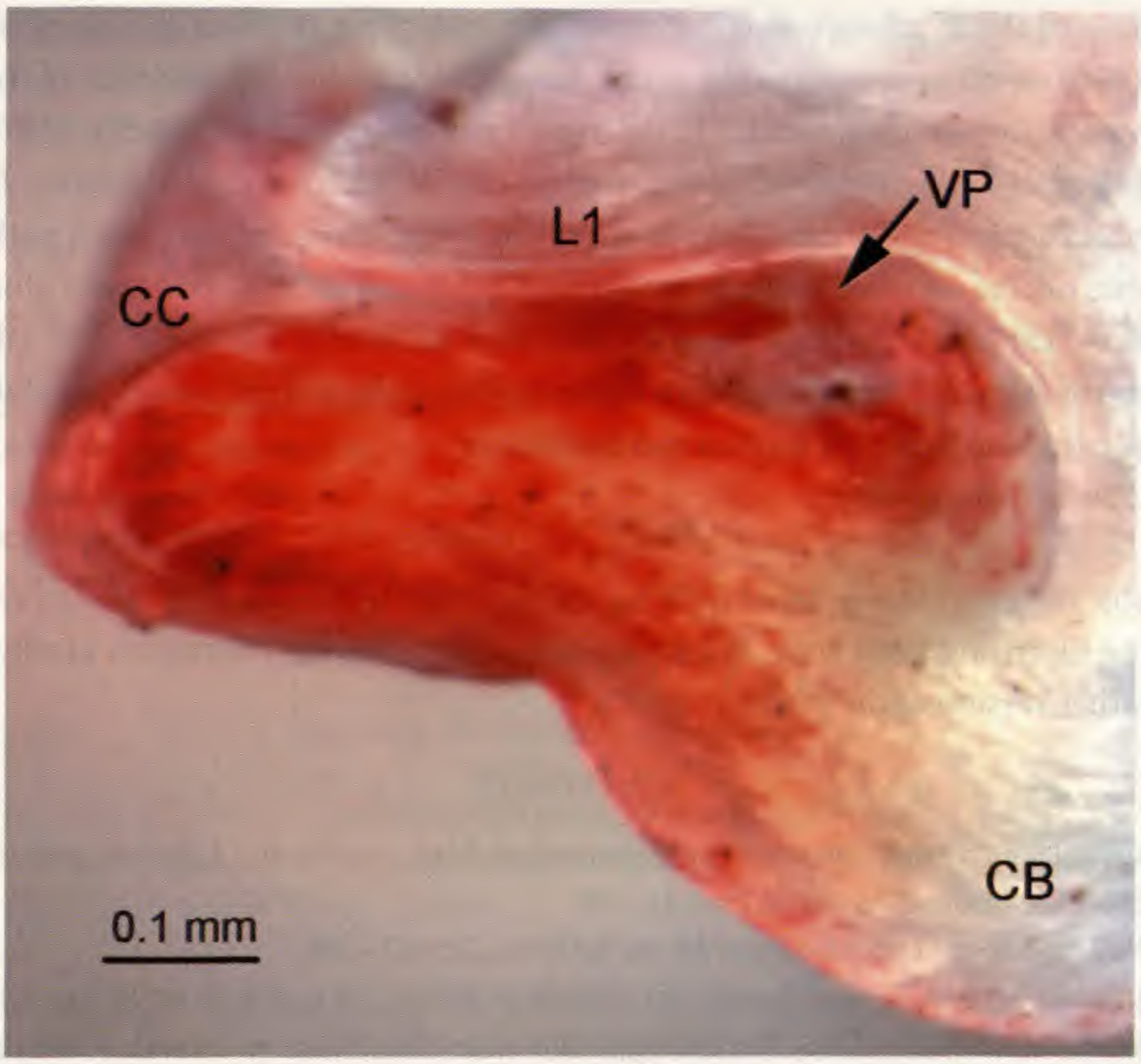

Fig. 4. Longitudinal section of *Eriochloa villosa* spikelet callus, stained with Sudan IV. CB = callus bead; CC = callus cup; L1 = lower lemma; VP = ventral projection. In this callus the ventral projection extends only about half the distance of the cup (apex just to the lower left of the "L1" annotation).

seen (Fig. 3 C). Long cells with interlocking cell walls were seen in the epidermis of the cup and the ventral projection.

Unlike the callus descriptions of most other *Eriochloa* species, occasional macrohairs were detected on both the lower and apical portions of the *E. villosa* callus (Table 1; Fig. 3 C), but see also Shaw and Smeins (1983). This is not unexpected as macrohairs are a common epidermal feature on other structures of *E. villosa* (cf., Thompson et al. 1990) and their occasional detection simply a function of the large numbers of *E. villosa* calluses examined.

The callus of untreated spikelets has an oily or waxy appearance (Fig 1A). Parenchyma cells of the cup portion and the ventral projection of the callus contained large vacuoles whose contents stained red with Sudan IV, indicating that this tissue is rich in lipids (Fig. 4). A lesser amount of staining occurred in the upper portion of the harder bead tissues of the callus. The large amount of lipids present in the fleshy callus cup suggests that this tissue may act as an elaiosome (myrmecochory) or animal attractant (Davidse 1987). No evidence was observed of oil secretion or accumulation in concave cavity formed by the cup (or ventral projection), as was suggested by Arriaga (2000). It is uncertain what types of vectors might serve as effective dispersal agents, but various types of insect and vertebrate (including birds and rodents) seed predators might be attracted to the lipid food source. Optimal seedling emergence was observed from soil depths up to about 5 cm, but occurred from depths > 9 cm (Liu & Owen 2003). This would suggest that diaspores can tolerate burial by seed caching animals.

The specific gravity of plant oils typically range from 0.91 to 0.97 at 15°C (Lide 1990). Large quantities of oils may affect buoyancy, movement and orientation (when unevenly distributed) of *E. villosa* diaspores under aqueous conditions. While the callus cup is unlikely to have a major impact on hydrochory, the increased buoyancy at the basal portion of the spikelet may provide some secondary functionality in diaspore transport and placement when free water is present.

The observations of the *E. villosa* callus are consistent with those of Shaw and Smeins (1979, 1983) and Thompson et al. (1990) on other species in the genus, but provide no further evidence of the ontogeny of the spikelet callus tissues. Although most similar to the Type 1 callus of Shaw and Smeins (1979), the most common type, slight differences were observed in the distribution of micro- and macrohairs. In most species of *Eriochloa* the lower glume is usually described as absent or greatly reduced and fused with the callus bead, however some species or taxa ascribed to the genus are said to have well-developed lower glumes and resemble species of *Brachiaria* (Clayton 1975; Gibbs Russell 1981; Shaw & Smeins 1983). Detailed anatomical study of these species (primarily African) is necessary for a better understanding of the *Eriochloa* callus homologies and the generic relationships of *Eriochloa*, *Urochloa* and *Brachiaria*.

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CHANGES TO *POTENTILLA RUBRICAULIS* S.L., *P. HOOKERIANA* (ROSACEAE), AND ERSTWHILE SYNONYMS IN *FLORA OF NORTH AMERICA NORTH OF MEXICO*

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ABSTRACT

An expanded discussion of the *Potentilla rubricaulis* complex is provided to complement the synoptic treatment in pending volume 9 of *Flora of North America North of Mexico* (FNANM). Most elements previously included in a broadly defined *P. rubricaulis* are now divided among seven subarctic and alpine species (*P. rubricaulis* s.s., *P. hookeriana, P. furcata, P. modesta, P. pseudosericea, P. paucijuga, P. saximontana*) and two arctic species (*P. uschakovii, P. pedersenii*). Arctic and subarctic plants previously included in *P. hookeriana* are now treated as *P. arenosa*. Additional minor or unresolved arctic elements that will not be given full treatment in FNANM include *P. borealis, P. murrayi, P. petrovskyi, P. psychrophila, P. lyngei* subsp. *spissa, P. insularis*, and *P. arctoalaskensis*, with *P. tolmatchevii, P. dezhnevii, P. tschaunensis*, and *P. safronoviae* as probable synonyms. The names *P. nivea* var. *pentaphylla* and *P. quinquefolia* do not apply to North American plants. The lectotype of *P. nivea* var. *subquinata* is interpreted as the hybrid of *P. nivea* and *P. arenosa*. The lectotype institution is designated for *Potentilla saximontana* Rydb.

KEY WORDS: *Potentilla rubricaulis, Potentilla hookeriana, Potentilla* nomenclature, *Flora of North America North of Mexico*

RESUMEN

Se adopta una discusión extensa del complejo *Potentilla rubricaulis* para complementar el tratamiento sinóptico en el volumen 9 de la *Flora of North America North of Mexico* (FNANM). La mayoría de los elementos Incluidos previamente en una *P. rubricaulis* definida ampliamente se dividen ahora en siete especies subárticas y alpinas (*P. rubricaulis* s.s., *P. hookeriana, P. furcata, P. modesta, P. pseudosericea, P. paucijuga, P. saximontana*) y dos especies árticas (*P. uschakovii, P. pedersenii*). Las plantas árticas y subárticas incluidas previamente en *P. hookeriana* se tratan ahora como *P. arenosa*. Los elementos árticos adicionales menores o no resueltos a los que no se les dará un tratamiento completo en la FNANM incluyen *P. borealis, P. murrayi, P. petrovskyi, P. psychrophila, P. lyngei* subsp. *spissa, P. insularis*, y *P. arctoalaskensis*, con *P. tolmatchevii, P. dezhnevii, P. tschaunensis*, y *P. safronoviae* como sinónimos probables. Los nombres *P. nivea* var. *pentaphylla* y *P. quinquefolia* no se aplican a plantas Norte Americanas. El lectotipo de *P. nivea* var. *subquinata* se interpreta como el híbrido de *P. nivea P. arenosa*. Se designa la institución del lectotipo para *Potentilla saximontana* Rydb.

NOMENCLATURAL BACKGROUND OF THE *POTENTILLA RUBRICAULIS* COMPLEX

Preparation of the first continent-wide treatment of *Potentilla* (Rosaceae) for North America since that of Rydberg (1908) required a full-scale revisionary effort to synthesize differing taxonomic concepts among regional and international floras. In particularly complex situations, the discussion that was needed to explain and justify the resultant changes was well beyond the scope of a synoptic flora. This was particularly true for the *P. rubricaulis* complex, which is accordingly published here instead.

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Regional floristic works in the last century (e.g., Polunin 1940; Porsild 1957; Hultén 1968; Porsild & Cody 1980; Welsh et al. 1993; Weber & Wittman 1996; Holmgren 1997) have generally used the name *Potentilla rubricaulis* Lehm. in a broad and often conflicting manner, for plants with at least some palmate to subpalmate (vs. strictly ternate) leaves and short styles (less than 1.5 mm) that are usually thickened and glandular-papillate basally. Alternatives have included the segregation of some elements as the ambiguous *P. quinquefolia* Rydb. (e.g., Hitchcock & Cronquist 1961; Boivin 1967; Dorn 1977) or the inclusion of *P. rubricaulis* in *P. pulchella* R. Br. (Scoggan 1978). As further confusion, Soják (1986, 1994) added *P. hookeriana* Lehm., a name previously used for a widespread species in the *P. nivea* L. complex, to the synonymy of *P. rubricaulis* s.l.

Although some of our early annotations and treatments (e.g., Elven & Aiken 2007) also reflect an inclusive *Potentilla rubricaulis*, we now conclude that several reasonably distinct species can be parsed, based on our combined studies of a broad range of material from the Arctic to the southern Rocky Mountains, increased attention to vestiture and inflorescence architecture, and new analyses of types, including some lectotypifications (Ertter 2008; Soják 1986). Most of these species collectively comprise *Potentilla* sect. *Rubricaules* (Rydb.) A. Nelson, used by us as a category of convenience for independently propagating species that purportedly originated as intersectional hybrids between members of ternate-leaved sect. *Niveae* (Rydb.) A. Nelson and pinnate- to subpalmate-leaved sect. *Pensylvanicae* Poeverl. Soják (1986) considered at least 30 species, mostly Eurasian, to be such intersectional hybrids. Jurtzev (1984) and Soják (1986) have treated the Eurasian variation in this group in detail; Soják's work also dealt with Greenland and North American species. He initially (1986) accepted several distinct North American species in the complex, but later (1994) reverted to an inclusive *P. rubricaulis* for non-arctic members of the section.

Listed below are the species comprising sect. *Rubricaules* in the pending volume 9 of *Flora of North America North of Mexico* (FNANM), plus additional taxa that have been included in *Potentilla rubricaulis* s.l., with full discussion and type paragraphs. Descriptions, keys, and distributions can be found in the pending FNANM treatment. Interpretations of probable parentage, mostly by Soják, are provided only for arctic and subarctic species. Problematic or minor elements not given full treatment in FNANM are also addressed, as are other erstwhile synonyms of *P. rubricaulis* s.l. Additional information and discussion on arctic species is available at the Panarctic Flora website (http://nhm2.uio.no/paf/).

SUBARCTIC AND TEMPERATE SPECIES IN FNANM

Outside of the Arctic, seven species previously included in *Potentilla rubricaulis* s.l. are being treated as distinct species in FNANM. These are only the best-defined elements morphologically and geographically, occurring primarily in the Rocky Mountains and subarctic regions of Alaska and western Canada. Further investigation is needed to resolve numerous poorly understood variants and transition zones, especially in western Canada. For example, plants from the northern prairies of Saskatchewan, Alberta, and Montana evidently represent an undescribed taxon, and collections from some other areas (e.g., Hoback Canyon, Wyoming; Schell Peak, Nevada) are also under investigation as possible novelties.

Potentilla rubricaulis Lehm., Nov. Stirp. Pug. 2:11. 1830. *Potentilla dissecta* Pursh var. *rubricaulis* (Lehm.) Rydb., Bull. Torrey Bot Club 23:396. 1896; *Potentilla nivea* L. subsp. *rubricaulis* (Lehm.) Hiitonen, Arch. Soc. Zool. Bot. Fenn. "Vanamo" 2:25. 1947[1949]. TYPE: CANADA: NORTHWEST TERRITORIES: "about [Great] Bear Lake, in lat. 66°" (not provided in protologue, but given by Lehm. in Fl. Bor.-Amer. (Hooker) 1:191. 1832), *Richardson s.n.* (LECTOTYPE, designated by Soják, Bot. Jahrb. Syst. 106:181. 1986: PR; ISOLECTOTYPES: BM, DR, E, K).

The narrow circumscription of *Potentilla rubricaulis* is restricted to relatively large plants with open inflorescences occurring mainly in glaciated parts of subarctic northwestern Canada and southern Alaska. Soják (1986) initially interpreted *P. rubricaulis* (including *P. furcata* A.E. Porsild) as the hybrid species originating from *P. arenosa* (Turcz.) Juz. (sect. *Niveae*) × *P. bimundorum* Soják (sect. *Pensylvanicae*), but later (1994) concluded that *P. litoralis* Rydb. was the more likely sect. *Pensylvanicae* parent for a broadly defined *P. rubricaulis*. The distinction between *P. rubricaulis* and large forms of *P. arenosa* with supernumerary leaflets is problematic, though the latter tends to have more stiffly spreading petiole hairs and prominently petiolulate central leaflets.

Shared with *P. bimundorum* are subappressed stem and petiole hairs, sparse glands, strongly revolute leaf margins, and raised, partly reticulate veins on epicalyx bractlets and sepals. The range of *P. rubricaulis* is largely within the glaciated area of overlap between *P. arenosa* and *P. bimundorum*, but the species is nearly absent from the unglaciated Beringian parts of Alaska and the Yukon Territory, even where the two presumed parents are both common.

Potentilla hookeriana Lehm., Del. Sem. Hort. Bot. Hamburg. 1849:10. 1849. *Potentilla nivea* L. var. *hookeriana* (Lehm.) Th. Wolf, Biblioth. Bot. 16(Heft 71):240. 1908; *Potentilla nivea L.* subsp. *hookeriana* (Lehm.) Hiitonen, Arch. Soc. Zool. Bot. Fenn. "Vanamo" 2:25. 1947 [1949]. TYPE: "America septententrionali" (probably CANADA): east side Rocky Mountains (possibly near Jasper House), *Burke s.n.* (LECTOTYPE, designated by Soják (as holotype), Bot. Jahrb. Syst. 106:201. 1986: PR; ISOLECTOTYPE: K).

The name *Potentilla hookeriana*, or its infraspecific equivalent under *P. nivea*, has traditionally been applied to a widespread primarily ternate-leaved member of sect. *Niveae*. As noted by Soják (1986), however, the type has at least some 5-foliate leaves, as do most other populations outside of the Arctic. As a result, the ternate-leaved arctic and subarctic material that was previously known as *P. hookeriana* has now taken *P. arenosa* (Turcz.) Juz. as the next available name. This occurred after a brief period when it was called *P. nivea* s.s. (e.g., Soják 1989; Cody 1996) until that name was conserved with a conserved type (Eriksen et. al. 1999), thereby maintaining *P. nivea* in its traditional sense for a separate species.

The name *Potentilla hookeriana* is retained by us but in a restricted sense, applied to mostly alpine plants from the Rocky Mountains and eastern Great Basin. In addition to encompassing most of traditional *P. hookeriana* from this area, our new circumscription also includes many 5-foliate collections previously identified as *P. rubricaulis*.

Potentilla furcata A.E. Porsild, Bull. Natl. Mus. Canada 121:224. 1951. *Potentilla hookeriana* Lehm. var. *furcata* (A.E. Porsild) Hultén, Ark. Bot. (n.s.) 7:72. 1968; *Potentilla rubricaulis* Lehm. var. *furcata* (A.E. Porsild) Soják, Bot. Jahrb. Syst. 106:209. 1986. TYPE: CANADA. YUKON TERRITORY: Canol Road, Rose-Lapie R. Pass near Mile 102, 19 Jul 1944, *Porsild & Breitung 10625* (HOLOTYPE: CAN; ISOTYPES: GH, UC, US).

Although included within *Potentilla rubricaulis* by Soják (1986, 1994), in our interpretation *P. furcata* differs in several characters that suggest a hybrid origin from *P. arenosa* and a glandular member of the *P. pensylvanica* L. complex. It is a characteristic species of the steppe bluffs of interior and south-central Alaska, Yukon Territory, and northern British Columbia, mainly within the unglaciated Beringian region (i.e., largely allopatric to *P. rubricaulis* s.s.).

Potentilla modesta Rydb., N. Amer. Fl. 22:331. 1908. *Potentilla concinna* Richardson var. *modesta* (Rydb.) S.L. Welsh & B.C. Johnst., Great Basin Naturalist 45:25. 1982. TYPE: U.S.A. UTAH. Piute Co.: Mt. Barette, Tushar Mts., 26 Jul 1905, *Rydberg & Carlton 7261* (HOLOTYPE: NY; ISOTYPE: UC).

Potentilla modesta is the dominant component of *P. rubricaulis* s.l. in the Intermountain Region (e.g., Holmgren 1997, including illustration). Plants generally have more consistently 5-foliate leaves and more congested inflorescences than *P. hookeriana*. Soják (1994) and Holmgren (1997) considered *P. modesta* to be a synonym of *P. rubricaulis* s.l., while Hultén (1945) included *P. modesta* in the synonymy of his primarily arctic concept of *P. nivea* subsp. *subquinata* (Lange) Hultén. The epithet *modesta* is misapplied in Welsh et al. (1993), where the combination *P. concinna* Richardson var. *modesta* (Rydb.) S.L. Welsh & B.C. Johnst. is used for long-styled plants placed by us in *P. concinna* var. *divisa* Rydb. (sect. *Concinnae* (Rydb.) A. Nelson).

Potentilla pseudosericea Rydb., Mem. Dept. Bot. Columbia Coll. 2:98. 1898. TYPE: U.S.A. "NEVADA. Esmeralda Co.:" [actually California, Mono Co.], White Mountains, 19 Aug 1888, *Shockley 592* (LECTOTYPE, designated by Ertter, J. Bot. Res. Inst. Texas 2:204. 2008: GH; ISOLECTOTYPES: GH, JEPS, UC).

As discussed elsewhere (Ertter 2008), the traditional use of *Potentilla pseudosericea* for plants endemic to the White Mountains on the border of California and Nevada was at odds with Rydberg's (1908) citation of "Rocky Mountains" as type locality. This citation resulted from the fact that two of the three syntypes were from the Rocky Mountains, both now identified as *P. bipinnatifida* Douglas ex Hook. in sect. *Pensylvanicae*. The traditional application has been preserved by lectotypification on the third syntype, purportedly from Nevada but

actually from California (Ertter 2008). Whether the species occurs in Nevada remains to be determined. Soják (1994) included *P. pseudosericea* within *P. rubricaulis* s.l.

Potentilla paucijuga Rydb., N. Amer. Fl. 22:348. 1908. *Potentilla pensylvanica* L. var. *paucijuga* (Rydb.) C. L. Welsh & B. C. Johnst., Great Basin Naturalist 42:31. 1982; *Potentilla rubricaulis* Lehm. var. *paucijuga* (Rydb.) Soják, Thaiszia 16:49. 2006. TYPE: U.S.A. UTAH: La Sal Mts., *Purpus 251 p.p.* (HOLOTYPE: US; ISOTYPE (fragment): NY).

Potentilla paucijuga, treated by us as endemic to the La Sal Mountains of Utah, was included in the synonymy of *P. rubricaulis* s.l. by Soják (1994) and Holmgren (1997). Plants have subpalmate leaves, with somewhat larger flowers and longer styles than sympatric members of sect. *Rubricaules*. In Colorado (e.g., Weber & Wittman 1996), the combination *P. pensylvanica* var. *paucijuga* (Rydb.) S.L. Welsh & B.C. Johnston has been misapplied to what is treated by us as *P. jepsonii* Ertter (sect. *Pensylvanicae*).

Potentilla saximontana Rydb., Bull. Torrey Bot. Club 23:399. 1896. *Potentilla rubripes* var. *saximontana* (Rydb.) Th. Wolf, Biblioth. Bot. 16 (Heft 71):205. 1908. TYPE: U.S.A. COLORADO: Wheeler's Exped., 1873, *Wolfe & Rothrock 366* (LECTOTYPE, designated here: GH; ISOLECTOTYPES: NY, US).

? *Potentilla nivea* L. var. *dissecta* S. Watson, Proc. Amer. Acad. Arts 8:559. 1873, not *Potentilla dissecta* Pursh; *Potentilla saximontana* Rydb. var. *dissecta* (S. Watson) Soják, Thaiszia 16:49. 2006. TYPE: CANADA: "Rocky Mountains of British America," *Drummond 368* (LECTOTYPE, designated by Ertter, J. Bot. Res. Inst. Texas 2:204. 2008: NY).

?*Potentilla pseudosericea* Rydb. var. *grandiflora* Th. Wolf, Biblioth. Bot. 16(Heft 71):153. 1908. TYPE: probably CANADA: Rocky Mountains, *Drummond s.n.* (LECTOTYPE, designated by Ertter (as holotype), Brittonia 44:432. 1992: DR; ISOLECTOTYPE: K).

Although often included in *Potentilla rubricaulis* s.l. (e.g., Holmgren 1997; Weber & Wittman 1996), *P. saximontana* differs in having subpinnate leaves and smooth columnar styles. It is accordingly placed by us in sect. *Subjugae* (Rydb.) A. Nelson rather than sect. *Rubricaules*, with many collections being transitional to *P. subjuga* Rydb. The species is restricted to high elevations in the mountains of Colorado, Montana, Utah, and Wyoming. Lectotypification of *P. saximontana*, provided above, is required only because a specific institution was not indicated in the protologue. Otherwise the GH specimen could be accepted as holotype, as the only known duplicate annotated with this name by Rydberg.

The lectotype of *Potentilla nivea* var. *dissecta* S. Watson has been tentatively included in *P. saximontana* (Ertter 2008), but *P. saximontana* is not otherwise known from the Canadian Rockies. The name *P. pseudosericea* var. *grandiflora* Th. Wolf, misapplied by Jepson (1936) to what is now called *P. morefieldii* Ertter, probably represents the same entity, and possibly the same *Drummond* collection.

Although references to Hooker's herbarium in the protologue might suggest that the type of *Potentilla pseudosericea* var. *grandiflora* is at Kew, Wolf (1908) is clearly referring to the specimen in his own herbarium, now at DR, which is annotated with this name and "NW Amerika/(ex herb. Hooker)/Lag mit echter P. diversifolia Lehm. zusammen". The corresponding sheet in Hooker's herbarium has a only a single specimen matching the DR specimen of *P. pseudosericea* var. *grandiflora* (K000762566), mounted with two large plants of *P. glaucophylla* Lehm. (formerly *P. diversifolia* Lehm.). This sheet provides the additional collecting information of "Rocky Mt/Drummond". A specimen in the Bentham herbarium (K000762567) is probably a duplicate, in spite of Hooker being the only person's name on the label.

ARCTIC SPECIES IN FNANM

Treatment of arctic variation in sect. *Rubricaules* is even more problematic than in temperate and subarctic areas, complicated by the challenge of applying the plethora of names based primarily on Eurasian types in a region with limited access and a complex post-glacial biogeography. At present, we find only two arctic components of sect. *Rubricaules* sufficiently uniform and widespread in North America to merit full treatment in FNANM: *Potentilla pedersenii* (Rydb.) Rydb. and a species to which we provisionally apply the name *P. uschakovii* Jurtzev. These two species constitute the major portion of what has been called *P. rubricaulis* in arctic Canada and Greenland (e.g., Porsild 1957; Hultén 1968; Böcher et al. 1978; Porsild & Cody 1980; Hultén & Fries 1986). The diagnostic morphological characters can be variable and overlapping, but the two species are nevertheless treated separately in part because of differences in putative parental combinations.

Potentilla uschakovii Jurtzev, Bot. Zhurn. (Moscow & Leningrad) 73:1613. 1988. TYPE: RUSSIA: Wrangel Island, "ad fontes fl. Somnitelnaja, 11 km ab ostio," 27 Jul 1986, *Jurtzev s.n.* (HOLOTYPE: LE).

Potentilla uschakovii was described by Jurtzev (1988) as endemic to Wrangel Island, the only place in Asia where the putative parents (*P. subvahliana* Jurtzev [sect. *Niveae*] and *P. pulchella* [sect. *Pensylvanicae*]) are sympatric. The original description deviates in major features from the arctic Canadian and Greenland plants to which we apply this name, not least in regularly ternate leaves. Our expanded use of the name is based solely on the interpretation of the same hybrid parentage, since *P. subvahliana* and *P. pulchella* are the only representatives of their groups within the American range of plants that we treat as *P. uschakovii* in FNANM. Morphologic features of North American *P. uschakovii* that are suggestive of *P. pulchella* as one parent include more than three deeply dissected leaflets and leaflet teeth with soft well-developed apical hair tufts. Other features point toward *P. subvahliana* as the second parent: caudex branches with persistent whole leaves, smooth petiole hairs, and one- or few-flowered inflorescences with large flowers. There is much variation among the North American plants, such that each island or population may have its own features. It is therefore probable that the species has arisen from numerous hybridization events.

Potentilla pedersenii (Rydb.) Rydb., N. Amer. Fl. 22(4):332. 1908. *Potentilla subquinata* (Lange) Rydb. var. *pedersenii* Rydb., Bull. Torrey Bot. Club 28:182. 1901. TYPE: GREENLAND: Disko Island, Vaigut Assuk, 25 Jul 1898, Pedersen 470 (LECTOTYPE, designated by Soják, Bot. Jahrb. Syst. 106:190. 1986: NY; ISOLECTOTYPES: C, S).

Potentilla tolmatchevii Jurtzev & Soják, Arktichesk. Fl. SSSR 9(1):320. 1984. TYPE: RUSSIA. SIBERIA: "in cursu inferiore fl. Jenisei prope pagum Sopocznaja Karga," 12 Aug 1926, *Tolmatchev 447* (HOLOTYPE: LE).

Soják (1986) interpreted *Potentilla pedersenii* to have arisen from crosses between *P. arenosa* subsp. *arenosa* and *P. pulchella*. Features of *P. pedersenii* that indicate *P. arenosa* as the sect. *Niveae* parent include no marcescent whole leaves, verrucose petiole hairs, and inflorescences with more and mostly smaller flowers than *P. uschakovii*. Like *P. uschakovii*, the species is polymorphic and probably the result of multiple hybridizations. It has, however, a coherent range in arctic North American, including Greenland. Reports of *P. pedersenii* from northeastern European Russia may perhaps involve *P. arenosa* subsp. *chamissonis* (Hultén) Elven & D.F. Murray rather than subsp. *arenosa* as one hybrid parent.

Jurtzev and Soják (in Jurtzev 1984) described *Potentilla tolmatchevii* from northern Asia as a hybrid species from *P. arenosa* subsp. *arenosa* × *P. pulchella*. Material annotated by Jurtzev as *P. tolmatchevii* and numerous collections from Ellesmere Island fit the American concept of *P. pedersenii*. The two species are therefore merged by us under the priority name.

Since *Potentilla pedersenii* was introduced by Rydberg (1908) as a "sp. nov.," the name is often treated as a newly described species (e.g., Soják 1986). However, Rydberg's inclusion of *P. subquinata* var. *pedersenii* in synonymy establishes the varietal name as a basionym, making *P. pedersenii* a new combination (K. Gandhi, pers. comm. 2011).

TAXA NOT GIVEN FULL TREATMENT IN FNANM

In addition to the preceding species being treated in FNANM, there are numerous local or scattered populations of *Potentilla* in the Arctic that combine characters from sect. *Niveae* and sect. *Pensylvanicae*, or that have otherwise been included in a broadly defined *P. rubricaulis*. Some of these may prove worthy of full taxonomic recognition as species of hybrid origin, as they propagate independently of their putative parents (probably mainly by agamospermy; cf. Eriksen 1996). Others are too different from place to place to deserve full species treatment, i.e., they are not fully stabilized or sufficiently widespread. The following such entities—named and adequately described as species—have been reported from arctic parts of North America and Greenland, but the evidence is insufficient for full treatment in FNANM.

Potentilla borealis Soják, Willdenowia 15:167. 1985. TYPE: RUSSIA: West Chukotka, "editum montanum Anyuyskoge, jugum Ilirniyskiy, systema lacus Tytyl," 19 Aug 1980, *Petrovsky 80-233* (HOLOTYPE: PR; ISOTYPE: LE).

Soják (1985) interpreted *Potentilla borealis* as the hybrid of *P. anachoretica* Soják (sect. *Pensylvanicae*) × *P. arenosa* subsp. *arenosa*. Reports by B.A. Jurtzev (in Elven & Aiken 2007) of this species from the Seward Peninsula (western Alaska) and Ogilvie Mountains (Yukon Territory) refer to plants with subpalmate to subpinnate leaves, very slender and silky hairy leaflet lobes, and many glands on the epicalyx bractlets and sepals. The last feature is not in accordance with the presumed parentage, so the identity of these North American plants as *P. borealis* remains to be confirmed.

Potentilla dezhnevii Jurtzev, Arktichesk. Fl. SSSR 9(1):318. 1984. Type: RUSSIA: East Chukotka: "Peninsula Tschukotskij, ad ripam dextram fl. Putukunei-veem (affluentiae sinistrae fl. Czegitun)," 20 Jul 1972, *Jurtzev s.n.* (holotype: LE).

?Potentilla murrayi Jurtzev, Bot. Zhurn. (Moscow & Leningrad) 78(11):80. 1993. Type: U.S.A. Alaska: Brooks Range, Mount Hultén, Dalton Hwy, 68°27'N 149°18'W, 2 Aug 1986, *Murray 9011* (holotype: ALA).

Jurtzev (1993) interpreted *Potentilla murrayi* as a hybrid species from *P. anachoretica* and *P. subvahliana*. It is a distinct local entity, forming significant and morphologically consistent populations in a small part of the Brooks Range. The hybrid assumption is partly supported by morphology: leaf dissection and vestiture resemble *P. anachoretica*, whereas the influence from *P. subvahliana* is very evident in its columnar tussocks, leaves, and flowers. Reports of *P. murrayi* from outside the central Brooks Range are based on rather different plants, not forming a morphologically consistent entity. It is debatable whether *P. murrayi* is distinct from *P. dezhnevii* of the Russian Far East, since Soják (2004) suggested that both have the same parentage. If so, *P. dezhnevii* would be the priority name.

Potentilla petrovskyi Soják, Cas. Nár. Mus., Odd. Prir. 153(2):102. 1984. Type: RUSSIA: South Chukotka: "Anadyr, r-n. ch. Pekulnej, r. Sev. Pekulnejveem," 1977, *Vassiljeva 77-212* (holotype: LE; isotype: PR).

Potentilla tschaunensis Juz. ex Jurtzev, Arktichesk. Fl. SSSR 9(1):317. 1984. Type: RUSSIA: West Chukotka: "districtus Czaunensis, regio ripae sinistrae fl. Olvegyrgy-vaam," 23 Jun 1951, *Schmorgunova s.n.* (holotype: LE).

Both of these species, described from the Russian Far East, were interpreted by Soják (2004) as *Potentilla anachoretica* × *P. nivea* s.l.; he accordingly synonymized *P. tschauensis* under *P. petrovskyi*. Plants conforming to Jurtzev's description are present on the Seward Peninsula, western Alaska. However, in our evaluation these collections do not constitute a coherent taxon, but rather a gathering of scattered hybrid biotypes. Other reports from northwest North America are based on plants included by Soják in *P. psychrophila*.

Potentilla psychrophila Soják, Thaiszia 16:94. 2007 [2006]. Type: U.S.A. Alaska: ne Brooks Range, Lake Peters area, Coke Creek drainage, 69°21'N 144°57'W, 29 Jun 1973, *Batten 250* (holotype: ALA).

The major portions of what had been annotated as *Potentilla rubricaulis* and *P. petrovskyi* in Alaska and Yukon Territory were transferred by Soják (2007) to his new species *P. psychrophila*, which he assumed to be a hybrid species from *P. litoralis* and *P. nivea*. The material annotated by Soják is polymorphic and may contain the products of several hybridizations, perhaps among different species. At least one part is morphologically consistent and is known to represent fairly large populations in central and northern Alaska and in the Yukon Territory, but whether this is an acceptable hybrid species remains in question.

Potentilla safronoviae Jurtzev & Soják, Bot. Zhurn. (Moscow & Leningrad) 73:1615. 1988. Type: RUSSIA. Siberia: "(Jacutia Orientalis arctica), promontorium Svjatei Nos, 1 km ab statione polari Svjatoi Nos ad austro-austro-orientem," 16 Aug 1976, *Safronova 706* (holotype: LE; isotype: PR).

Potentilla lyngei Jurtzev & Soják subsp. **spissa** Soják, Feddes Repert. 117:496. 2006. Type: GREENLAND: Wollaston Forland, Herschell, 1964, Rosenberg s.n. (holotype: PR).

Soják (2006) described *Potentilla lyngei* subsp. *spissa* based on plants previously identified by Danish botanists as either *P. rubricaulis* or *P. pulchella*. This plant has a significant range and consistent morphology in northeast Greenland. It is accordingly a candidate for recognition as an independent taxon, but in our understanding not as a subspecies of *P. lyngei*. We agree with Sojak's treatment of *P. lyngei* subsp. *lyngei* (sect. *Pensylvanicae*) as a distinct taxon in north European Russia, with one close relative in the Russian Far East (*P. wrangelii* V.V. Petro-

vsky, Wrangel Island). However, in our interpretation, plants annotated by Soják as *P. lyngei* subsp. *spissa* (or an unpublished combination as a subspecies of *P. insularis*) are probably hybrids between *P. pulchella* and *P. hyparctica* Malte (sect. *Aureae* (Rydb.) Juz.). As such, *P. lyngei* subsp. *spissa* is a synonym of *P. safronoviae*, described from Siberia.

Potentilla insularis Soják, Bot. Jahrb. Syst. 106:203. 1986. TYPE: NORWAY: Svalbard, Spitsbergen, Hyperithatten, 28 Aug 1908, *Resvoll-Dieset s.n.* (HOLOTYPE: O).

Potentilla insularis, described from Svalbard and east Greenland, was interpreted by Soják (1986) as *P. arenosa* subsp. *chamissonis* × *P. lyngei* s.l. Soják believed *P. lyngei* subsp. *lyngei* to be the sect. *Pensylvanicae* parent of the Svalbard plants, but subsp. *spissa* (= *P. safronoviae*) to be the corresponding parent of the Greenland plants. The hybrid origin of *P. insularis* has been contested for morphological and molecular reasons (Hansen et al. 2000; Hamre 2000). The Svalbard *P. insularis*, however, has proved very close to Greenland *P. pedersenii* in gross morphology and to *P. arenosa* subsp. *chamissonis* in RAPD multilocus phenotypes (Hansen et al. 2000).

Potentilla arctoalaskensis Jurtzev, Bot. Zhurn. (Moscow & Leningrad) 78(11):79. 1993. TYPE: U.S.A. ALASKA: Seward Peninsula, 18.5 miles SW of Deering near Utica Creek, 65°53'N 163°5'W, 23 Jun 1978, *Wright 42* p.p. (HOLOTYPE: ALA).

Potentilla arctoalaskensis is evidently known only from the type, which Jurtzev (1993) interpreted as *P. arenosa* × *P. litoralis*. The type sheet is a mixed collection with an unnamed variant of *P. litoralis* that is the common form in Alaska. Typical *P. litoralis* barely enters Alaska from the southeast.

EXCLUDED NAMES

Potentilla nivea L. var. **pentaphylla** Turcz., Bull. Soc. Imp. Naturalistes Moscou 16(4):607. 1843. *Potentilla nivea* [var.] *quinquefolia* Rydb., Bull. Torrey Bot. Club 23:302. 1896; *Potentilla quinquefolia* Rydb., Mem. Dept. Bot. Columbia Coll. 2:76. 1898. TYPE: RUSSIA. SIBERIA: "ad fl. Okam," *Kuznetsov s.n.* (HOLOTYPE: proabably LE).

Potentilla nivea L. [var.] **subquinata** Lange, Meddel. Gronland 3:9. 1880. *Potentilla subquinata* (Lange) Rydb., Bull. Torrey Bot. Club 28:181. 1901; *Potentilla nivea* L. subsp. *subquinata* (Lange) Hultén, Bot. Not. 1945:135. 1945. TYPE: GREENLAND: Disko Island, Quannersuit, 23 Jun 1871, *Fries s.n.* (LECTOTYPE, designated by J. Soják, Bot. Jahrb. Syst. 106:198. 1986: C).

Among the other names that have been used for American members of sect. *Rubricaules* are *Potentilla nivea* var. *pentaphylla* "Lehm." and its substitute name *P. quinquefolia* Rydb. Sojâk (1986), for example, included both names in his synonymy of *P. hookeriana* and designated a lectotype at PR, based on a specimen from the Hooker herbarium from "America septentr." This interpretation results from the traditional attribution of *P. nivea* var. *pentaphylla* to Lehmann (Del. Sem. Hort. Hamburg. 1850:12. 1850), sometimes with reference to an earlier publication (Lehmann in Fl. Bor-Amer. (Hooker) 1:195. 1832). The earlier publication includes a description but lacks the actual combination, and by the time of the later publication the combination had already been validly published by Turczaninow. Lehmann's putative combination is therefore at best an isonym of *P. nivea* var. *pentaphylla* Turcz., as accepted by Wolf (1908). By current taxonomy (e.g., Juzepczuk 1941; Soják, pers. comm., 2011), Turczaninow's type is a variant of *P. altaica* Bunge, endemic to central Asia. Neither the name *P. nivea* var. *pentaphylla* nor *P. quinquefolia* therefore has any application in North America. As an alternative interpretation, Porsild (1951) called *P. quinquefolia* a *nomen confusum* to be discarded.

Another commonly used name, *Potentilla nivea* var. *subquinata* Lange (= *P. subquinata* (Lange) Rydb.), has generally been considered a heterotypic synonym of the preceding names (e.g., Rydberg 1908, Hultén 1945). However, we interpret the lectotype designated by Soják (1986) as the casual hybrid of *P. nivea* and *P. arenosa* that is common throughout the sympatric ranges of these species, for which *P. prostrata* Rottb. is the priority name. Since both of the putative parents are in sect. *Niveae*, the epithet *subquinata* is not applicable to any member of sect. *Rubricaules*. Normally trifoliolate species in sect. *Niveae* will occasionally produce supernumerary leaflets, especially under favorable conditions (Eriksen & Nyléhn 1999).

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BOOK REVIEW

JANE GOODALL WITH GAIL HUDSON AND FORWARD BY MICHAEL POLLAN. 2013. **Seeds of Hope: Wisdom and Wonder from the World of Plants.** (ISBN-13: 9781455513222, hbk.). Grand Central Publishing, Hachette Book Group, 237 Park Avenue, New York, New York 10017, U.S.A. (**Orders:** www.hachettebookgroup.com/publishers/grand-central-publishing). $22.36, 384 pp., 36 color photos, many b&w photos, 6" × 9".

In the early 1970s my father arrived home one evening with two tickets to attend a talk by Jane Goodall sponsored by the Appalachian Mountain Club of Boston. To a budding 12-year-old environmentalist, the opportunity to see Jane Goodall, recently back from Gombe, and to hear her in person talk about her experience in East Africa was a dream come true. Goodall was a personal heroine then and has been an inspiration since, and it was with great joy that I jumped at the opportunity to review her recent book *Seeds of Hope*.

Known primarily for her work with chimpanzees, Jane Goodall has written a new book, *Seeds of Hope: Wisdom and Wonder from the World of Plants*, that in many ways serves as a capstone to her life's work as in it she reflects upon her lengthy career and the impact that plants have had on her life and research. From a child climbing the Beech tree in the family yard, to the forests of Gombe, and to her present work as a voice for the environmental movement, Goodall reflects on the plant kingdom, weaving in stories from her own experiences and from the many collaborations she has had over the years. In fact, she refers to her book as a gathering of stories.

Seeds of Hope is divided into four parts. It begins with a look at Goodall's childhood home, "The Birches" in Bournemouth, England, and how her "love for the natural world" developed. She then spends time discussing the plant kingdom, providing us with an overview of the structure and function of plants, and offers us a glimpse of the great variety of plants around the world from the small, hardy tundra plants of Greenland and the lush forests of the Sumatran jungles, to those "unwanted weeds" that grow in our gardens. Goodall then turns to provide us with a history of plant collecting and its manifestations today. She begins with Carl Linnaeus and his intrepid explorations through unmapped Lapland and brings us through to the 21st century to the current "plant hunters" who work with botanical gardens and research institutes around the world to "collect, protect, cultivate, and propagate" plants, organizations such as the Kew Royal Botanical Gardens in England and the Botanical Research Institute of Texas.

Part two of the book addresses the human uses of plants. In this section she discusses medicinal plants and the importance of indigenous knowledge in identifying plants for medicinal purposes. She highlights two individuals, Mark Plotkin in the Amazon and Vandana Shiva in India, both of whom have committed their lives to working with indigenous groups to learn about medicinal plants and to ensure that indigenous knowledge is not exploited by western pharmaceutical companies through what Shiva terms "biopiracy."

In part three, Goodall turns to the history of plantation farming, focusing on the development of tobacco, rice, cotton, wheat, potatoes, and corn. Throughout she illustrates how the cultivation of these monocultures "provided huge economic benefits to plantation owners while causing massive human suffering (including health issues and child labor) and environmental degradation (including habitat and water loss and increased pesticide, herbicide, and fertilizer use)." She then turns to a discussion of genetically modified organisms (GMOs), addressing the genetic alteration of plant DNA and describing it as "a monstrous crime against plants." She highlights the development of the "super pests" and "super weeds," the result of creating insect- and herbicide-resistant plants. Goodall paints a dark picture of the multiple risks of GMOs to the health of plants, animals, and humans.

Goodall, however, is an optimist. She doesn't leave us in the dumps feeling there is nothing that can be done. Instead she offers us hope. In part four, she provides examples of organically grown tea, coffee, and cacao, demonstrating sustainable farming methods. She provides illustrations of urban and community gardening.

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PREVIOUSLY UNRECOGNIZED TYPES OF AMERICAN *ACACIA* SPECIES FROM THE TORINO HERBARIUM (TO)

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ABSTRACT

Investigation of specimens for plants either native to or adventive in the New World and originally described as *Acacia* species, or later transferred to that genus, at the Herbarium Universitatis Taurinensis resulted in the location of previously unrecognized type materials for *Acacia adenanthera, A. alba, A. angico, A. bancroftiana, A. brasiliensis, A. compta, A. lasiopus, A. mollicoma, A. myriophylla, A. plumosa, A. pterocarpa, A. ramosissima, A. rubiginosa, A. spini*, and *A. velutina*. For *Acacia spini* Balb. ex de Spin, a neotype has been designated.

KEY WORDS: *Vachellia, Senegalia, Acacia, Mimosa, Piptadenia, Parapiptadenia*, mimosoid legumes, Fabaceae, Mimosoideae

RESUMEN

Investigaciones de especimenes de plantas tanto nativas como adventicias en el Nuevo Mundo y descrita originalmente como especies *Acacia*, o transferidas posteriormente a ese género, del Herbarium Universitatis Taurinensis resultaron estar en lugares de material tipo no reconocidas peviamente de *Acacia adenanthera, A. alba, A. angico, A. bancroftiana, A. brasiliensis, A. compta, A. lasiopus, A. mollicoma, A. myriophylla, A. plumosa, A. pterocarpa, A. ramosissima, A. rubiginosa, A. spini*, y *A. velutina*. Para *Acacia spini* Balb. ex de Spin, se ha designado un neotipo.

The Herbarium Universitatis Taurinensis (TO) is a rich source of type materials for species that have been placed in the genus *Acacia*. In the process of identifying type materials for species originally described as *Acacia* sensu lato (s.l.) or at some time transferred to that genus, a search was made of herbarium materials of Colla, de Spin, and Martius at TO. Previously unrecognized probable and potential type materials were discovered. In order to put these findings into proper context, some historical background concerning the collectors, persons associated with the collections at TO, and the history of the herbarium are needed.

History of Herbarium Universitatis Taurinensis (TO)

The Herbarium of the University of Turin (TO) was established in 1891, about 160 years after the foundation of the Orto Botanico of the Università di Torino (1729), and is one of the most important Italian herbaria with about one million 1,000,000 specimens. In addition to two phanerogamic collections, *Herbarium Pedemontanum* (TO-HP, about 112,000 specimens) and *Herbarium Generale* (TO-HG, about 260,000 specimens), the Herbarium possesses several important collections, such as Carlo Allioni's herbarium, from which materials are not available for loan or exchange (Vignolo-Lutati 1951, 1952). These *exsiccata* or dried specimens document more than 250 years of botanical studies including those of the first floristic research in Piedmont (Piemonte), carried out by Carlo Allioni (1728–1804) and his collaborators (Allioni 1785), as well as several important early expeditions including that of Vitaliano Donati (1717–1762) to Egypt (1759–1762) (Forneris et al. 2008), H.R.H. Luigi Amedeo di Savoia, Duke of Abruzzi, to Ruwenzori (1906) and the Wabi Scebele in Ethiopia (1928–1929) (Mattirolo 1911; Forneris & Montacchini 1984; Guglielmone 2004).

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A number of American collections of J.J. Bernhardi, L.A. von Chamisso and A.R. Delile, (North America), C. Bertero and F.W. Sieber (Antilles, South America), A.M.A. Bonpland (Central America), C.F.P. Martius and G. Casaretto (Brazil), from the early 1800s, including those are conserved in the herbaria of Giovanni Battista Balbis (18,000 specimens) and Luigi Colla (10,000 specimens) (Guglielmone et al. 2009; Baldini & Guglielmone 2012).

Giovan Battista Balbis (1765–1831)

Giovan Battista Balbis, a member of prestigious Italian and European Academies, was an important botanist of the 19th century; he was a correspondent with Augustin Pyramus DeCandolle, Jacques J. Labillardière and Kurt Sprengel, among others. Balbis was a student of Allioni; he graduated in medicine in 1785 and in 1794 he was a physician in Napoleon's Army in Italy. In 1801, Balbis was appointed Professor of Botany and Director of the University Botanic Garden in Turin, posts he held until 1814 when, after the defeat of Napoleon and the restoration of the Savoia monarchy, he was exiled. In 1819, Balbis served in the same role at the University of Lyon, where he remained until 1830, when his poor health obliged him to leave France and return to Piedmont. He died in early 1831 (DeCandolle 1831; Colla 1833; Stafleu & Cowan 1976:107–109; Forneris & Pistarino 1990). Although Balbis' studies involved the Italian and French flora [*Flora Ticinensis* (Nocca & Balbis1816–1821)], written with the collaboration of Domenico Nocca (1758–1841), and *Flore Lyonnaise* (Balbis 1827–1828), between 1801 and 1814, he published 14 catalogs of the Botanic Garden of Turin and one of the Garden of Lyon in 1826. In these publications, he added the descriptions of some new species that were cultivated in the Gardens. Under his direction, the number of species cultivated in the Botanic Garden of Turin increased considerably. In 1801, there were more than 3,500 species, but in 1812 this number had grown to about 6,000 (Balbis 1801; 1812; 1813). Under his direction, there was an increased interest in exotic flora and the focus of the institution expanded from the geographic limits of the Piedmont region to a worldwide perspective. New greenhouses were built, where many plants from Africa and America were cultivated; for some of these species this represented the first introduction into Italy (Saccardo 1909; Maniero 2000). Many of these collections were obtained by personal exchanges with other Italian and European botanists and either University or private Gardens. The richness of plants cultivated in the Botanic Garden is documented by the drawings collected in *Iconographia Taurinensis* (Forneris 2008). This collection, 7640 drawings in 64 volumes, represents plants cultivated in the Garden between 1752 and 1868, the year when the last painter died (see Chiapusso Voli 1904). Many plants cited in the Balbis' catalogs are included in volumes 35 to 47 of this series (Forneris 2008).

Balbis made a remarkable herbarium, considered one of the most important of the time; the collection includes the plants he collected as well as specimens obtained in exchange from other botanists. In 1831, after Balbis' death, his herbarium was bought by Giuseppe Giacinto Moris (1796–1869), director of the Botanic Garden in Turin. Because the University did not hold a collection of dried specimens (*exsiccata*) at that time, Balbis' materials were the first holdings of the current herbarium (Mattirolo 1929).

Carlo Giuseppe Luigi Bertero (1789–1831)

Carlo Giuseppe Luigi Bertero, a correspondent and close friend of Balbis, was one of the first Italian naturalists to visit the New World, collecting a large amount of botanical material from little known areas. Bertero was born on 14 October 1789 in Santa Vittoria d'Alba (Piedmont, near Turin). He studied Medicine at the University of Turin, where he attended lessons of botany at the Botanic Garden by Balbis. After his graduation in 1811, he practiced the medical profession for several years.

In 1816, Bertero moved to Paris where he met many important botanists such as René Louis Desfontaines, Jean Louis Loiseleur-Deslongchamps and, especially, Christiaan Hendrik Persoon; this botanist helped him in studying the Flora of the Antilles and assisted him in obtaining an appointment as a ship's doctor on the ship *Guadelupe*, which sailed for Martinique in August 1816.

The details of this first expedition results were carefully recorded in Bertero's manuscript, a field book in which he wrote about the localities visited and the plants observed, about his correspondence with Balbis and Colla, and about his collections. These documents trace the following itinerary: Guadeloupe (1816–1818),

Saint Thomas (1818), Puerto Rico (1818–1819), Santo Domingo, Haiti (1819–1820), Colombia (Santa Marta, Barranquilla, Mompós and part of Rio Magdalena) (1820–1821), and Jamaica (1821) (see also Urban 1902).

In 1821, Bertero returned to Paris, but later returned to Turin where he met with Balbis in order to study his new collections. Balbis sent many of Bertero's specimens to Kurt Sprengel in Berlin for identification, but Bertero's field book was sent to A.P. DeCandolle in Geneva; in this field book, 1746 species are cited; most of these are described and the morphological details illustrated. DeCandolle (1825) included descriptions of the new Caribbean taxa reported by Bertero in his *Prodromus*. In 1857, Alphonse DeCandolle returned Bertero's manuscript to Turin. At present, the largest part of Bertero's collections from the West Indies and Colombia, about 2,000 taxa, is conserved at TO in Balbis' and Colla's collections. Duplicates of Bertero's material are also found in other herbaria including B, FI, HAL, L, M, MEDEL, MO, MPU, NY, P, P-JU, S, WB.

In 1827, Bertero returned to Paris where he planned his next expedition to Chile, following the suggestions made by A.P. DeCandolle and Benjamin Delessert to explore a land for which the flora was poorly known. In October 1827, he embarked on a ship from Le Havre to Valparaiso, Chile, again as a ship's doctor. Reconstruction of this second journey is complex: data about the itinerary are based only on specimen labels and Bertero's correspondence with Balbis and Colla. The Chilean localities visited include: Valparaiso, Rancagua, Quintero, M.te La Leona, M.te la Punta des Cortes, Quillota, Tagua Tagua lagoon, Concoa River, Rio Claro, and Cachapoal.

In 1828–1829, Bertero published a list of several species he had observed in the newspaper *Mercurio Chileno*. In this list, he proposed several new species, but unfortunately because he did not add descriptions, these epithets are *nomina nuda*. In early 1830, Bertero went to the Juan Fernández Islands (Isla Mas a Tierra) with the English botanist A. Caldeleugh. On September 28, 1830, Bertero sailed from Chile to the Society Islands with the General Consul of North America J.A. Morenhout and on November 4, 1830, he arrived in Tahiti, where he collected plants actively for a few months. He departed on April 9, 1831, for Valparaiso, but died in the shipwreck of his boat near Raiatea island (for detailed information about Bertero's biography see: Mattirolo 1932; Vignolo-Lutati 1955, 1956; Delprete et al. 2002).

Before his final unlucky voyage, Bertero sent his Chilean collections to Baron Delessert in Paris who distributed duplicate sets of *exsiccatae* to Balbis, Colla, and A.P. DeCandolle, but kept back the rest of these collections (about 15,000 specimens) for Bertero. Several years after Bertero's death, these were sold by Delessert's heirs to a Travel Company of Esslinger owned by E. Steudel and C.F. Hochstetter (1840); later these materials were dismantled and dispersed. Bertero entrusted his Tahitian collection to Morenhout, who in 1834 sent these materials to A. Dessalines d'Orbigny in Paris, although by that time, a portion of this material was missing (Guillemin 1836, 1837). Despite the fact that J.A.Guillemin reported that some duplicates were sent to the Royal Academy of Turin, no Bertero specimens from Tahiti were conserved in Turin. At the present time, Bertero's Chilean material (about 300 specimens) are found in Colla's herbarium.

Luigi Colla (1766–1848)

Luigi Colla was a lawyer and an expert botanist whose botanical knowledge was appreciated by the most important botanists of that time. A.P. DeCandolle, J. Lindley and K. Sprengel, named new genera after him. Colla was a member of prestigious Italian and European academies; in 1822, he even became a member of the Academy of Natural History of Philadelphia. These affiliations permitted him to have many correspondents with whom he made exchanges of plants and *exsiccata*. Colla published several works in the *Memorie della Reale Accademia delle Scienze di Torino* between 1820 and 1848, including monographs of exotic genera such as the genus *Musa*, which included the description of two species, *Musa balbisiana* and *M. acuminata* (Colla 1820). Colla established a botanic garden in Rivoli (near Turin), the *Hortus Ripulensis*, for which he published catalogs of plants cultivated between 1824 and 1831 (Colla 1824, 1827a, 1827b, 1829, 1831). In these catalogs, Colla also reported descriptions of new species, often with the respective drawings made by his daughter Tecofila Colla Billotti. In 1829, the number of species cultivated in the garden increased to more than 2000 species belonging to approximately 700 genera (Colla 1831): the greatest part of these were exotic and included a number of plants obtained from seeds sent by Bertero from the Antilles.

Colla was a close friend of Bertero and, after Bertero's death, Colla published descriptions of the new Chilean genera and species based on Bertero's specimens collected during the second expedition, including those listed by Bertero in 1828–1829 in the *Mercurio Chileno*. In 1834, Colla (1834a) published a paper entitled "Plantes rariores in regionibus Chilensibus a clarissimo M.D. Bertero nuper detectae", in which he described several new taxa; he again published the same description for some of these species in another work, *Herbarium Pedemontanum* (Colla 1833–1837) (for more details about the priority of publications see Pichi-Sermolli 1951, 1952). In both works Colla enclosed drawings of new taxa made by his daughter. Two more species from Bertero's *exsiccata* were published by Moris (1834, 1835).

Colla's herbarium included about 10,000 specimens; this collection includes *exsiccata* obtained from the plants grown in his botanic garden, Bertero's expeditions, and exchanges with several Italian and European botanists including specimens from Giovanni Biroli (1772–1825) from Piedmont (Guglielmone, 2008), Jacob Corinaldi (1782–1847), from Egypt (Forneris et al. 2008), Carl Friedrich Philipp von Martius (1794–1868) from Brazil (Fryxell 1976; Stafleu & Cowan 1981:325–339), and Maximilian A.P. von Wied-Neuwied (1782–1867) (P.L.R. de Moraes, personal communication). On April 25, 1849, after Colla's death, his son donated his collection to the University of Turin; the catalog of this herbarium, handwritten by Colla himself, accompanied the specimens (for more detailed information about Colla's biography see: Parlatore 1850; Delponte 1852; Mattirolo 1929:44).

Marquis Luigi Raimondo Novarina di Spigno (1760–1832)

Marquis Luigi Raimondo Novarina di Spigno (1760–1832), known as Marquis De Spin, was a passionate botanist who established an important garden in San Sebastiano Po (near Turin) at the beginning of the 19th century. Bertero sent the seeds of several species from the Antilles to De Spin, who listed the species present in his garden in seven catalogs published between 1804 and 1823. He exchanged living plants and *exsiccata* with several correspondents, among these were Balbis and Colla. The international relationships that he maintained allowed a constant and conspicuous increment of the species grown in the San Sebastiano garden; moreover he acclimatized and introduced into cultivation several exotic species that were subsequently sent to many Piedmont gardens.

De Spin acknowledged his gratitude to Bertero for the seeds, material and information obtained from him through Balbis in his catalog of 1823. De Spin prepared specimens from several plants in his garden. Approximately 700 specimens based on Marquis' living collections, now mostly included in Balbis' herbarium, have been identified in TO (for more detailed information about De Spin biography and collection see: Guglielmone et al. 2006).

History of *Acacia*

As conceived by Willdenow (1806, 1809), Kunth (1823, 1825), DeCandolle (1825) and other early taxonomists, the genus *Acacia* was quite diverse; many of the species now belong to other genera of mimosoid legumes, among them *Mimosa* (Barneby 1991), *Calliandra* (Barneby 1998), *Pithecellobium*, *Albizia*, and *Lysiloma* (Barneby & Grimes 1996, 1997). Based largely on the concepts of Bentham (1842, 1875, 1876), the genus *Acacia* later was limited to species with numerous stamens (20–200) and filaments free to the base. This concept remained largely the same until the 20th century when Vassal (1972) and Pedley (1978) refined the subgeneric treatment of this rather large genus. Pedley (1986) suggested that the genus *Acacia* should be divided into three genera, *Acacia*, *Senegalia*, and *Racosperma*. Nonetheless, most workers continued to accept *Acacia* s.l. until Maslin et al. (2003) suggested that the time had come to depart from this viewpoint.

The taxonomy of *Acacia* became more contentious when in 2005, the International Botanical Congress in Vienna approved a proposal to change the type of the genus *Acacia* Miller from an African species, *A. scorpioides* (L.) W.F. Wight [= *A. nilotica* (L.) Delile; *Acacia* subgen. *Acacia*] by recognizing an Australian species *A. penninervis* [*Acacia* subg. *Phyllodineae*] as a conserved type (Orchard & Maslin 2003; McNeill et al. 2005). Acceptance of this retypification remains controversial (Brummitt 2011; Linder & Crisp 2011; Luckow et al. 2005; Moore & Cotterill 2011; Moore 2007, 2008; Moore et al. 2011a; Moore et al. 2011b; Rijckevorsel 2006;

Smith & Figueiredo 2011; Smith et al. 2010; Smith et al. 2006; Thiele et al. 2011). However, the retypification was upheld recently at the XVIII International Botanical Congress in Melbourne (McNeill & Turland 2011; Smith & Figueiredo 2011).

Apart from these arguments, both morphological and molecular data for *Acacia* s.l. (Acacieae), Ingeae, and Mimoseae, strongly support segregation of *Acacia* s.l. into at least five entities: the genera *Vachellia* (Seigler & Ebinger 2005; Kodela & Wilson 2006), *Senegalia* (Seigler & Ebinger 2009, 2010; Seigler et al. 2006a), *Acaciella* (Britton & Rose 1928; Rico-Arce & Bachman 2006), *Mariosousa* (Seigler et al. 2006b), and *Acacia* (primarily Australian species of the former subgenus *Phyllodineae*).

Acacia specimens in TO

A number of types or possible type material for American species of *Acacia* is found at TO, although many of these are now recognized as members of other genera. Others were originally described in other genera, but were later considered to be members of *Acacia* s.l. There are approximately 500 specimens of *Acacia* presently assigned to 198 taxa in the "Herbarium Generale." Several of these are included in the collections of herbaria of Balbis and Colla.

Although Balbis listed 164 specimens of *Acacia* in the catalog of his herbarium, only 117 are presently found in the collection; among these are 36 specimens sent by Bertero from Guadeloupe in 1819, Santo Domingo and Puerto Rico in 1820, and Santa Marta (Colombia) and Jamaica in 1821. Dates on the labels refer to the years when Balbis received the specimens (Vignolo-Lutati 1955). There are also eight specimens from the Botanic Garden of Turin (between 1800 and 1813) and six from De Spin's garden (between 1818 and 1825) (the Marquis listed 47 species of *Acacia* in his catalogs).

The catalog of Colla's herbarium includes 104 *Acacia* specimens; presently only 96 are found. Among these, nine specimens from "Herbarium Martii," probably represent duplicates of Martius' collections; six of these likely came from collections of von Wied-Neuwied (P.L.R. de Moraes, personal communication). There are also 36 specimens cited in *Hortus Ripulensis*; Colla listed 50 specimens of *Acacia* in the catalogs of his garden. Thirty-four more *exsiccata* are from the West Indies with labels handwritten by Bertero.

A careful search of materials at TO reveals specimens associated with many of the historically important figures outlined above, that are either original materials examined by these botanists, or in a number of cases type materials. Most of these specimens have not been considered in recent taxonomic studies involving mimosoid legumes. The status of these exsiccata is discussed below:

TYPES OR ORIGINAL MATERIALS OF *ACACIA* SENSU LATO AT TO

1. Acacia adenanthera Schult. ex Colla, 1834. Herb. pedem. 2:266, n. 71. (**Fig. 1**). Nom. illeg. non Zeyh. ex Steud. (1821).

Specimens examined: Two labels: "*Acacia adenanthera* / ex H. Rip. 1824 8r [= october] e semin: missis a / Schultesio, hoc anno n: fl: [= nondum floruit];" "*Acacia adenanthera*," both labels hw. Colla, TO-HG, herb. Colla.

Neither flowers nor fruits are mentioned in the original description; the country of origin is not known. The specimen lacks prickles and spines; the leaves are bipinnate with 2–3 opposite pairs of pinnae and 12 pairs of leaflets per pinna. The rachillae of the pinnae are winged. The leaflets are opposite with more or less central venation (Fig. 1). Colla (1834b 2:266, n. 71) notes that there is a gland at the base of the petiole. The gland appears to be flattened and ovate in outline. This specimen is not an *Acacia* s.l., but appears to be a mimosoid legume. We cannot identify it to genus.

The collector was probably Joseph August Schultes (1804–1840), a botanical collector for Roemer or his father Julius Hermann Schultes (1773–1831), an Austrian botanist in Brazil. Most of their collections were in northeastern Brazil, especially Pernambuco.

2. Acacia alba De Spin, Le Jardin de St. Sébastien soit Catalogue 27. 1818. (**Fig. 2**). Nom. illeg. non Wildenow (1806), *Calliandra alba* (Colla) Benth. ex Jackson, Index Kew. 1:385. 1895.

Notes.—The name *Acacia alba* is treated as a heterotypic synonym of *Zapoteca portoricensis* (Jacq.) H.M. Hern. var. *flavida* H.M. Hern., Ann. Missouri Bot. Gard. 73:758. 1986. Country of origin not known.

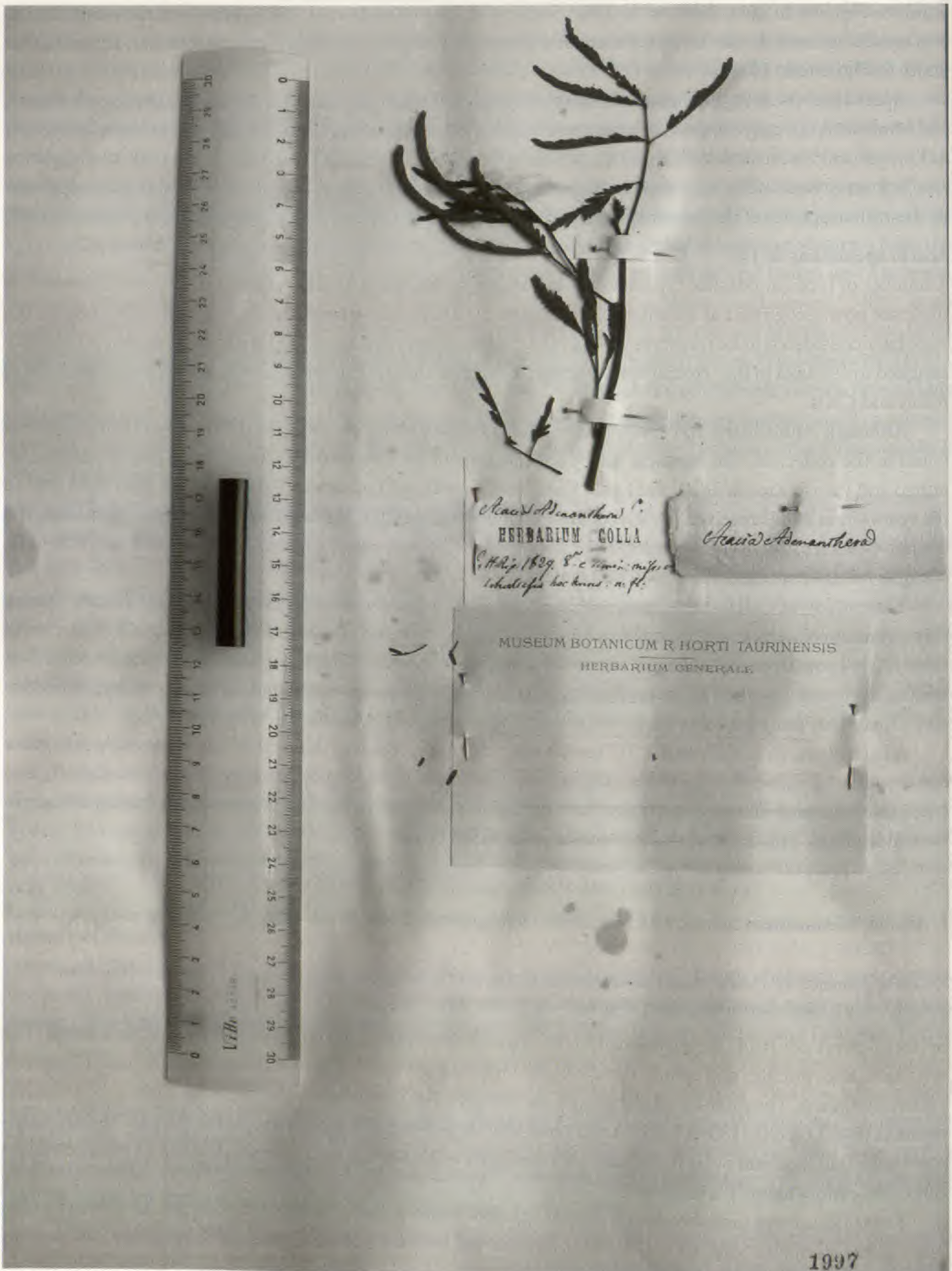

Fig. 1. Original materials of *Acacia adenanthera* Schult. ex Colla.

Fig. 2. Original materials of *Acacia alba* De Spin.

Specimens examined: Two labels: "*Acacia alba* W. / ex H. Ripul. 1829 8ʳ in calid. / raro floret;" "Acacia alba," both labels hw. Colla, TO-HG, herb. Colla.

The species was listed and described in the catalog of S. Sebastiano garden (De Spin 1818, pp. 5, 27, note 1). Moreover, it is described in the second appendix to the catalog of *Hortus Ripulensis* (Colla 1827b:339, note 1); the plant was received from a garden sited in Buttigliera (on the hills near Turin) owned by Count Francesco Lorenzo de Freylino (1758–1820) and at that time directed by M. Pangella. This garden was very important in the 18th century, particularly for the collections of exotic plants. In the three catalogs of the garden (Freylino 1785, 1808, 1810) this species was not listed. Colla (1834b 2:362, n. 33) also cited this species. This species was early accepted (Steudel 1841, Bentham 1875; for complete descriptions and distribution see Barneby 1998; Barneby & Grimes 1996; Hernández 1986, 1989; Zuloaga 1999).

3. Acacia angico Mart. in Colla, Herb. pedem. 2:268. 1834. (**Fig. 3**). *Senegalia angico* (Mart. in Colla) Seigler & Ebinger, Phytologia 92:91. 2010. TYPE: BRAZIL: Villa Nova (LECTOTYPE, here designated: TO; ISOLECTOTYPES: BM, K, P).

Specimens examined: Two labels: hw. Martius, "Acacia angico Mart. / Villa Nova Brasil / Communic. Martius 1827;" hw. Colla, "Acacia angico;" TO-HG, herb. Colla ex herb. Martius.

Although Colla's handwritten label confirms the earlier name *Acacia angico* on the label written by Martius, the description (Colla 1834b) agrees more closely with the type of *Acacia plumosa* Martius in Colla. Because Colla did provide a Latin binomial and at least a generally accurate description and diagnosis, *Acacia angico* was validly and effectively published. Further, the specimen at TO represents materials seen by Colla and we designate that specimen as a lectotype for the species. Because the name of the species follows the type specimen, not the accuracy of the description, that name must be accepted.

Bentham (1876) considered *Acacia angico* Martius to be a synonym of *Piptadenia rigida* Bentham (1842) [now recognized as *Parapiptadenia rigida* (Benth.) Brenan (1963)] suggesting that Bentham was influenced by Colla's descriptions, although Colla was not cited. A Martius specimen of authentic *Acacia angico* at Kew (K264972), labeled as such in Martius' handwriting and apparently identical to material seen by Colla at TO was annotated by Bentham as *Acacia plumosa* Lowe. The descriptions of other authors are often based on erroneously interpreted materials of *Acacia angico* Martius in Colla (Boggan et al. 1997; Rico-Arce 2007; Barneby et al. 2007).

4. Acacia bancroftiana Bertero ex Colla, Hortus Ripulensis 1. 1824. (**Fig. 4,** upper left specimen). TYPE: JAMAICA. "1693 /Acacia Bancroftiana Bert. / Jamaica 1821 Majo" (LECTOTYPE, here designated: TO; ISOLECTOTYPE: G-DC).

Notes.—The name *Acacia bancroftiana* is currently treated as a heterotypic synonym of *Caesalpinia vesicaria* L., 1753. Sp. pl. 1:381.

Specimens examined: hw. Balbis, "*Acacia bancroftiana* / Bertero / *e* Jamaica *D.* Bert.," TO-HG, herb. Balbis; left, hw. Bertero, "1693 / *Acacia bancroftiana* Bert. / Jamaica 1821 Majo / ... [unreadable letters]," TO-HG; right, hw. Bertero, "*Acacia bancroftiana* Bert. / Jam. 1821 Jul.," TO-HG; hw. Bertero, "*Acacia bancroftiana* / Bertero / Jamaica frutiulis;" TO-HG.

This species was listed in the catalog of San Sebastiano garden (De Spin 1823) and described by Colla (1824:1, note 2). In 1821, Bertero (1816–1821) recorded the description of the species in his fieldbook, in fascicle 13 of "Stirpes in Provincia S. Marthae Continent. Amer. Austral. Lectae 1821" (pp. 1042–1043, n. 1693). The four specimens can be considered as syntypes. Sample 2a reports the original collection number by Bertero and is selected as the lectotype (Fig. 3). This species is discussed in more detail by subsequent authors (DeCandolle 1825; Mabberley 1981; Rico-Arce 2001).

5. Acacia brasiliensis Colla, Mem. Reale Accad. Sci. Torino 33(1):135. 1829. (**Fig. 5**). Nom. illeg. non Sprengel (1826). *Acacia brasiliensis* Spreng., Syst. veg. 3:142. 1826. = *Calliandra* sp.

Notes.—According to Bentham (1875), based on the imperfect diagnosis, Sprengel's material of *Acacia brasiliensis* may not be distinct from *Calliandra bella* (Mart. ex Spreng.) Benth., London J. Bot. 3:110. 1844.

Specimens examined: Two labels: "Acacia brasiliensis / ex H. Ripul. 1820 / Spr: III. 42 125 non quadrat / ... [unreadable word] enim aculeata;" "Acacia brasiliensis?"; both labels hw. Colla; TO-HG, herb. Colla.

The specimen was from a plant cultivated in the garden owned by the Litta family in Lainate (near Milan) and given to Colla by the gardener Giuseppe Tagliabue. The species was described in the third appendix of *Hortus*

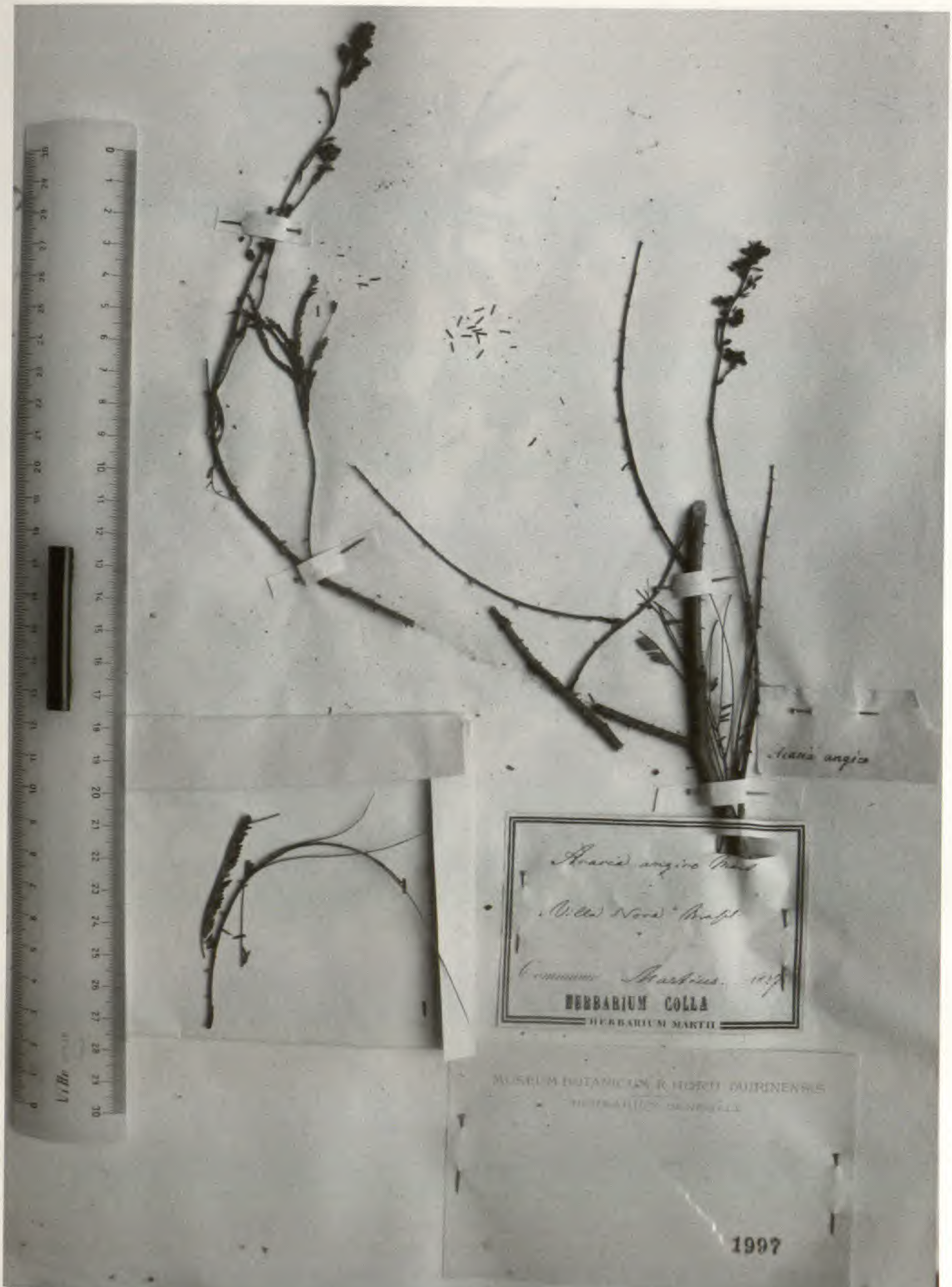

FIG. 3. Lectotype of *Acacia angico* Mart. in Colla.

Fig. 4. Lectotype of *Acacia bancroftiana* Mart. ex Colla (upper left).

FIG. 5. Original materials of *Acacia brasiliensis* Colla.

Ripulensis (Colla 1829:135, note 1) and listed in *Herb. Ped.* (Colla 1834b, 263, n. 47). Colla reported that the plant has two glands on the petiole (Colla 1829:135, note 1), but we were unable to observe petiolar glands on the specimen examined. A drawing of this species was found in *Iconographia Taurinensis* (Vol. 51, t. 16); the volume is estimated to be dated between 1829 and 1831 (Forneris 2008). These characters are compatible with the genus *Mimosa.*

6. Acacia compta Mart. in Colla, Herb. pedem. 2:268. 1834. (**Fig. 6**). Type: BRAZIL: "*Acacia compta* Mart. / S. Pedro d'Algoa Brasil / communic. Martius 1827," (lectotype, here designated: TO).
Notes.—Present status unknown.

Specimens examined: Two labels: hw. Martius, "*Acacia compta* Mart. / S. Pedro d'Algoa Brasil / communic. Martius 1827;" hw. Colla, "*Acacia compta,*" TO-HG, herb. Colla ex herb. Martius.

The flowers of the spicate inflorescences have 8–10 stamens. The leaflets have subcentral venation with conspicuous venation on the adaxial side. The prickles are paired at the nodes (Fig. 6). There is a small gland at the base of the petiole (Colla 1834b). These characters are compatible with *Adenopodia, Mimosa or* most probably a *Piptadenia* species. The specimen conserved in TO-HG is evidently part of the type material. There is no indication that the specimen in TO was the only material used by Martius, thus it is not considered as the holotype, but designated as the lectotype (ICBN art. 9 note 1).

7. Acacia lasiopus Mart. in Colla, Herb. pedem. 2:267, n. 74. 1834. (**Fig. 7**). Type: BRAZIL: "Acacia lasiopus Mart. / Ad Fl. Ilheos Brasilia / Communic. Martius 1827" (lectotype, here designated: TO). No type materials seen at M in 2007.
Notes.—The name *Acacia lasiopus* is possibly a *Senegalia* species.

Specimens examined: Two labels: hw. Martius, "Acacia lasiopus Mart. / Ad Fl. Ilheos Brasilia / Communic. Martius 1827;" hw. Colla, "Acacia lasiopus;" TO-HG, herb. Colla ex herb. Martius.

The flowers of this specimen have approximately 50 stamens. According to Colla (1834b), the leaves have 4–6 pairs of elliptic leaflets and the species is eglandular. This specimen appears to be a mimosoid legume of tribe Ingeae, but the paucity of characters does not permit further assignment of this taxon.

8. Acacia mollicoma Mart. in Colla, Herb. pedem. 2:267, n. 73. 1834. (**Fig. 8**). Type: BRAZIL: "*Acacia mollicoma* Mart. / Campos Novos Brasil / communic. Martius 1827" (lectotype, here designated: TO). The specimen was sent by Martius. No type materials seen at M in 2007.
Notes.—Possibly *Parapiptadenia rigida* (Benth.) Brenan, but not *Acacia* s.l. species.

Specimens examined: Two labels: hw. Martius, "*Acacia mollicoma* Mart. / Campos Novos Brasil / communic. Martius 1827," / hw. Belli, corrected "*Acacia mollissima;*" hw. Colla, "*Acacia mollicoma*"/ signed "non iuste" / Belli; TO-HG, herb. Colla. Saverio Belli (1852–1919) was the director of the Botanic Garden of Turin between 1898 and 1900.

Although Colla (1834b) states that there are no petiolar glands, they are evident on the specimen itself. Campos Novos is in current-day Sta. Catarina. Based on Burkart (1979), this specimen, which is unarmed (Fig. 8), may be *Parapiptadenia rigida* (Benth.) Brenan, which has been collected there in recent years. Perhaps other genera of tribe Mimoseae should be considered as well.

9. Acacia myriophylla Mart. in Colla, Herb. pedem. 2:266, n. 72. 1834. (**Fig. 9**). Type: BRAZIL: "*Acacia myriophylla* Mart. / Cap. Frio, near Rio de Janeiro, Brasil / communic. Martius 1827" (lectotype, here designated: TO). No type materials found at M in 2007 (Colla 1837).
Notes.—Possible *Piptadenia* or *Mimosa* species; not a member of *Acacia* s.l.

Specimens examined: Two labels: hw. Martius "*Acacia myriophylla* Mart. / Cap. Frio Brasil / communic. Martius 1827;" hw. Colla, "*Acacia myriophylla;*" TO-HG, herb. Colla.

The specimen conserved in TO-HG is evidently part of the type material. There is no indication that the specimen in TO was the only material used by Martius, thus it is not considered as the holotype but designated as a lectotype (ICBN art. 9 note 1).

Colla (1834b) described this species and enclosed a drawing made by his daughter (Colla 1837, tab. 62, fig. 1). He noted that there are no (petiolar) glands and that the plant is unarmed. The number of stamens (10

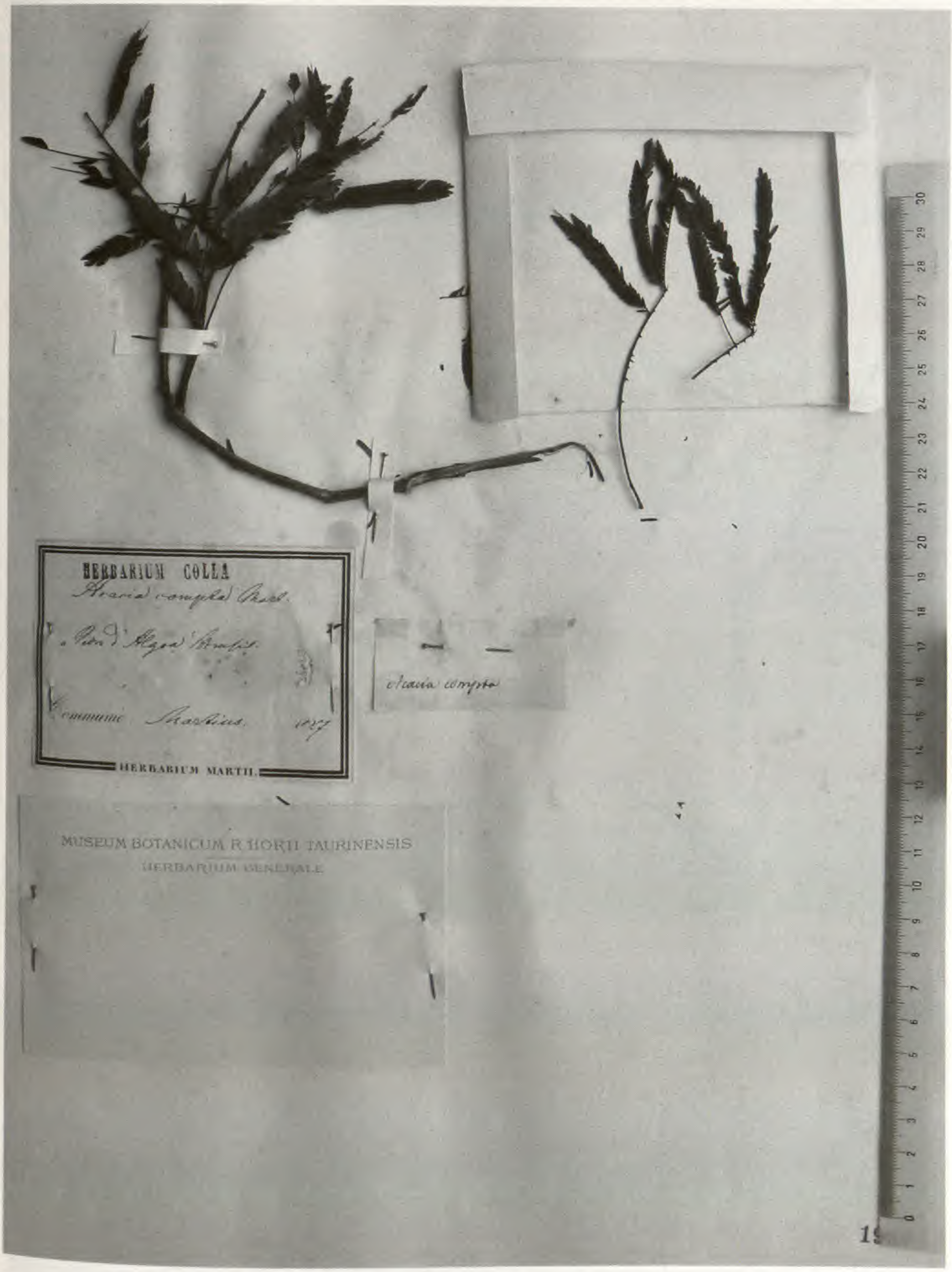

FIG. 6. Lectotype of *Acacia compta* Mart. in Colla.

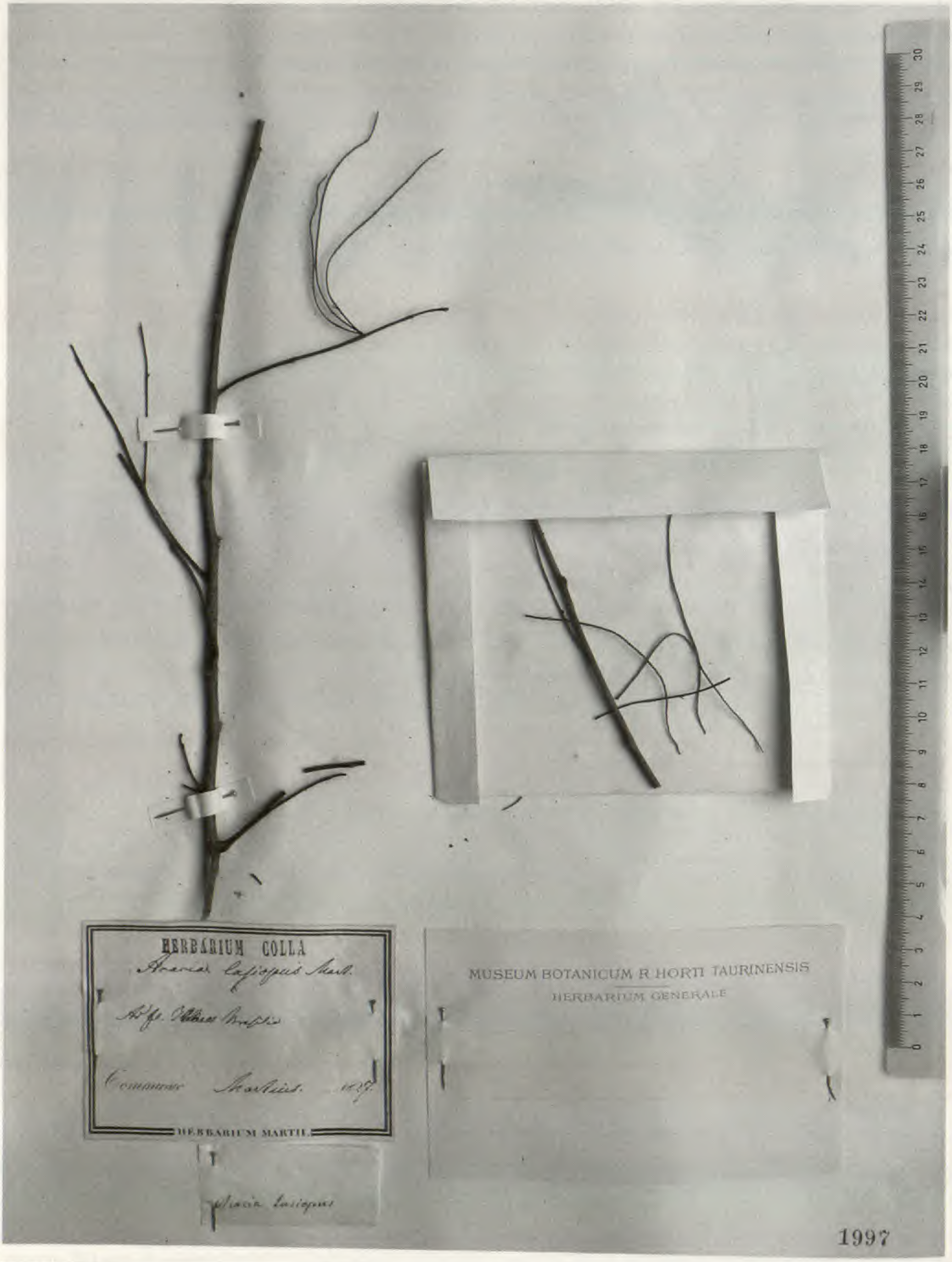

Fig. 7. Lectotype of *Acacia lasiopus* Mart. in Colla.

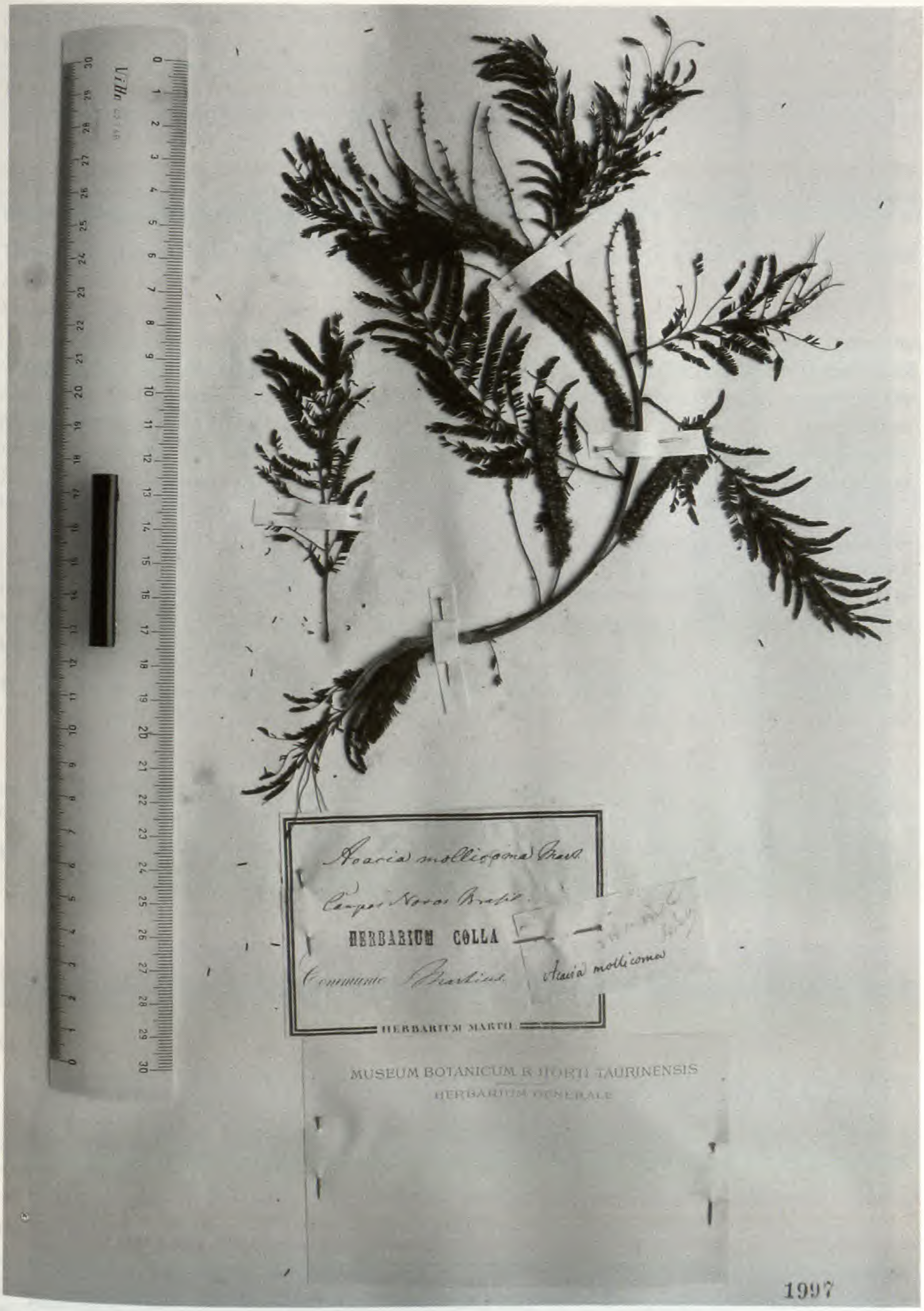

FIG. 8. Lectotype type of *Acacia mollicoma* Mart. in Colla.

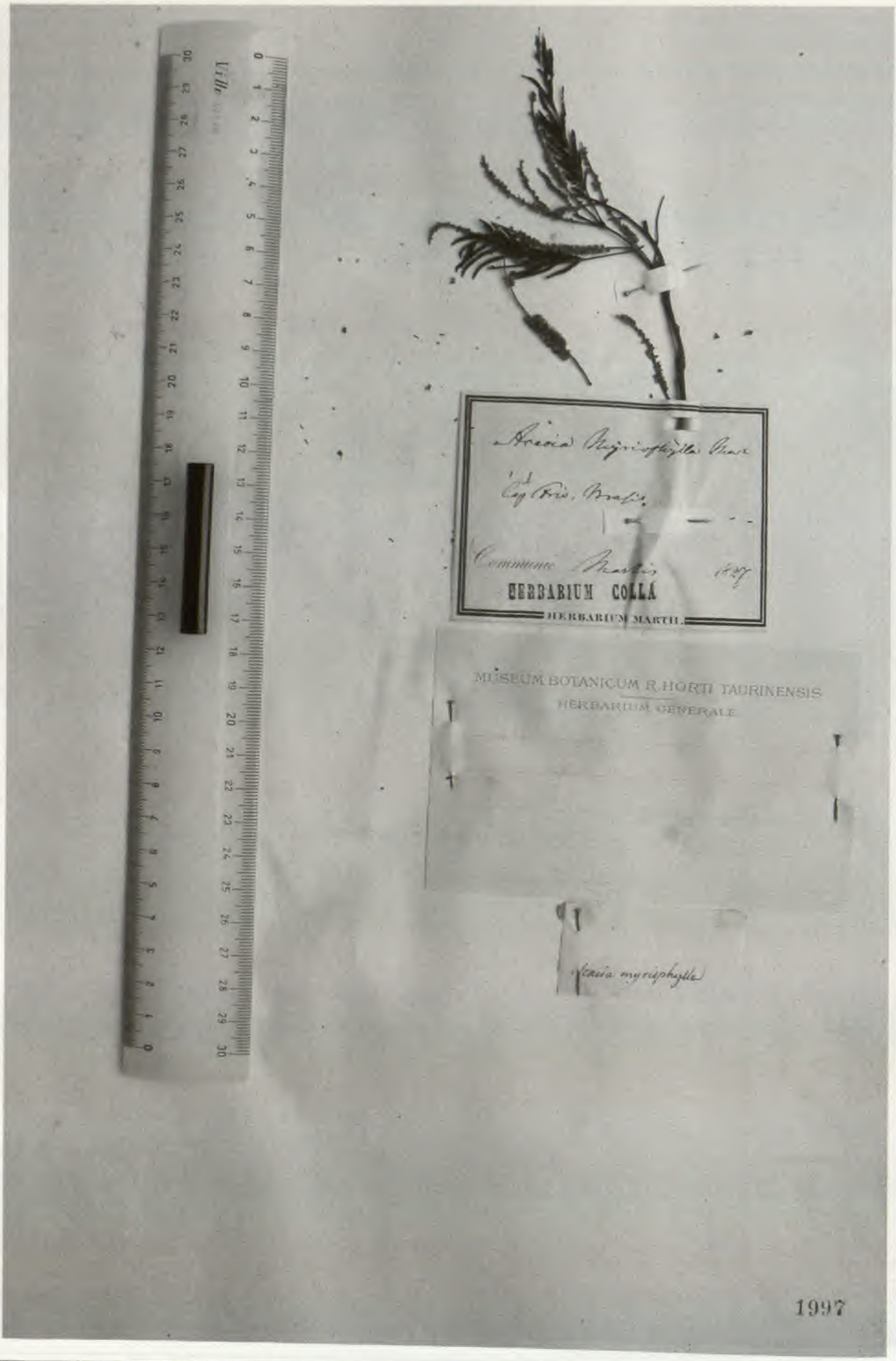

Fig. 9. Lectotype of *Acacia myriophylla* Mart. in Colla.

or possibly even 5) indicates that this species belongs to the Mimoseae, perhaps to the genera *Parapiptadenia* or *Pseudopiptadenia* (**Fig. 10**).

10. Acacia plumosa Mart. *ex* Colla. Herb. pedem. 2:267, Jul 1834. (**Fig. 11**). TYPE: BRAZIL: "Acacia / Villa Nova do Vermehr Brasil/ A. plumosa Colla / communic. Martius 1827" (LECTOTYPE, here designated: TO).

Notes.—Probably *Piptadenia trisperma* (Vell.) Benth.

Specimens examined: Two labels: hw. Martius, "Acacia / Villa Nova do Vermehr Brasil / A. plumosa Colla / communic. Martius 1827." On the reverse side of this label, the description that appears in Colla (1834b) is written in Colla's handwriting (Seigler et al. 2006a; Rico-Arce 2007); hw. Colla "Acacia plumosa."

This specimen has spicate inflorescences and prickles, some of which appear to be paired at the nodes, but are also scattered on the petioles. The glands are depressed at the base of the petioles. Leaflet venation is more or less central. These characters are quite similar to those of *Piptadenia trisperma* (Vell.) Benth.

Although Colla's handwritten label gives the name *Acacia plumosa* on the label written by Martius, the description written on the reverse side of the Martius label (Colla 1834b) agrees more closely with the type of *Acacia angico* Martius in Colla (see above). Because Colla did provide a Latin binomial and at least a generally accurate description and diagnosis, *Acacia plumosa* was validly and effectively published. Further, the specimen at TO represents materials seen by Colla and we designate that specimen as a lectotype for the species. Because the name of the species follows the type specimen, not the accuracy of the description, that name must be accepted.

The fact that Bentham (1876) considered *Acacia angico* Martius to be a synonym of *Piptadenia rigida* Bentham (1842) [now recognized as *Parapiptadenia rigida* (Benth.) Brenan (1963)] and a Martius specimen of authentic *Acacia angico* at Kew (K264972), labeled as such in Martius' handwriting and apparently identical to material seen by Colla at TO was annotated by Bentham as *Acacia plumosa* Lowe suggests that Bentham was influenced by Colla's descriptions, although Colla was not cited.

11. Acacia pterocarpa Bertero in Colla, Herb. pedem. 2:265. 1834. (**Fig. 12**). TYPE: "Acacia pterocarpa ?/ e sem. Miss. A Bertero e Duad.?/ Lam. [two unreadable words]/ Ex hort. Rip. 1829 / non videtur differre a Leucocephala et glauca/ a nobis cultis" (LECTOTYPE, here designated: TO).

Notes.—The name is presently a heterotypic synonym of *Leucaena leucocephala* (Lam.) de Wit, Taxon 10:53. 1961.

Specimens examined: Two labels: hw. Colla "Acacia pterocarpa ?/ e sem. Miss. A aBertero e Guad.? / Lam. [two unreadable words] / Ex hort. Rip. 1829 / non videtur differre a Leucocephala et glauca / a nobis cultis," hw. Colla "Acacia pterocarpa."

12. Acacia ramosissima Mart. in Colla, Herb. pedem. 2:268. 1834. (**Fig. 13**). TYPE: BRAZIL: "In sylvis praemitivis Brasil / Communic. Martius 1827" (LECTOTYPE, here designated: TO).

Notes.—Probably a *Mimosa* species.

Specimens examined: Two labels: hw. Martius, "In sylvis praemitivis Brasil / Communic. Martius 1827;" hw. Colla, "Acacia ramosissima."

There are no petiolar glands. The number of stamens varies from 7–9. This species might possibly be *Piptadenia ramosissima* (Bentham 1842; Lewis 1987), but alternatively could be a *Mimosa* species.

13. Acacia rubiginosa Martius in Colla, Herb. pedem. 2:268. 1834. (**Fig. 14**). TYPE: BRAZIL: "Mimosa / Campos des Looglorasen Brasil / Communic. Martius 1827," (LECTOTYPE, here designated: TO). On label: *Mimosa* [hw. Martius]. *Acacia rubiginosa* Colla [hw. Colla].

Notes.—A *Mimosa* sp.

Specimens examined: Three labels: hw. Martius, "Mimosa / Campos des Looglorasen Brasil / Communic. Martius 1827." On the reverse side of this label, the description that appears in Colla (1834b) is written in Colla's handwriting; hw. unknown, "Mimosa / Campos dos Loaglacasen;" hw. Colla, "Acacia rubiginosa."

This specimen may have been collected at Campos de Goytacazes or Goitacazes (Goytacasen in German), a locality in the northeastern part of present-day Rio de Janeiro, Brazil. Based on the image of the specimen and a later figure (Colla 1837, tab. 62, fig. 2; Fig. 10)) this is clearly a *Mimosa* species and resembles *Mimosa pellita* Humb. & Bonpl. ex Willd., but cannot be ascribed to that species with certainty. Other possible, but less likely, species might be *M. tarda* Barneby or *M. elliptica* Benth. (Barneby 1991).

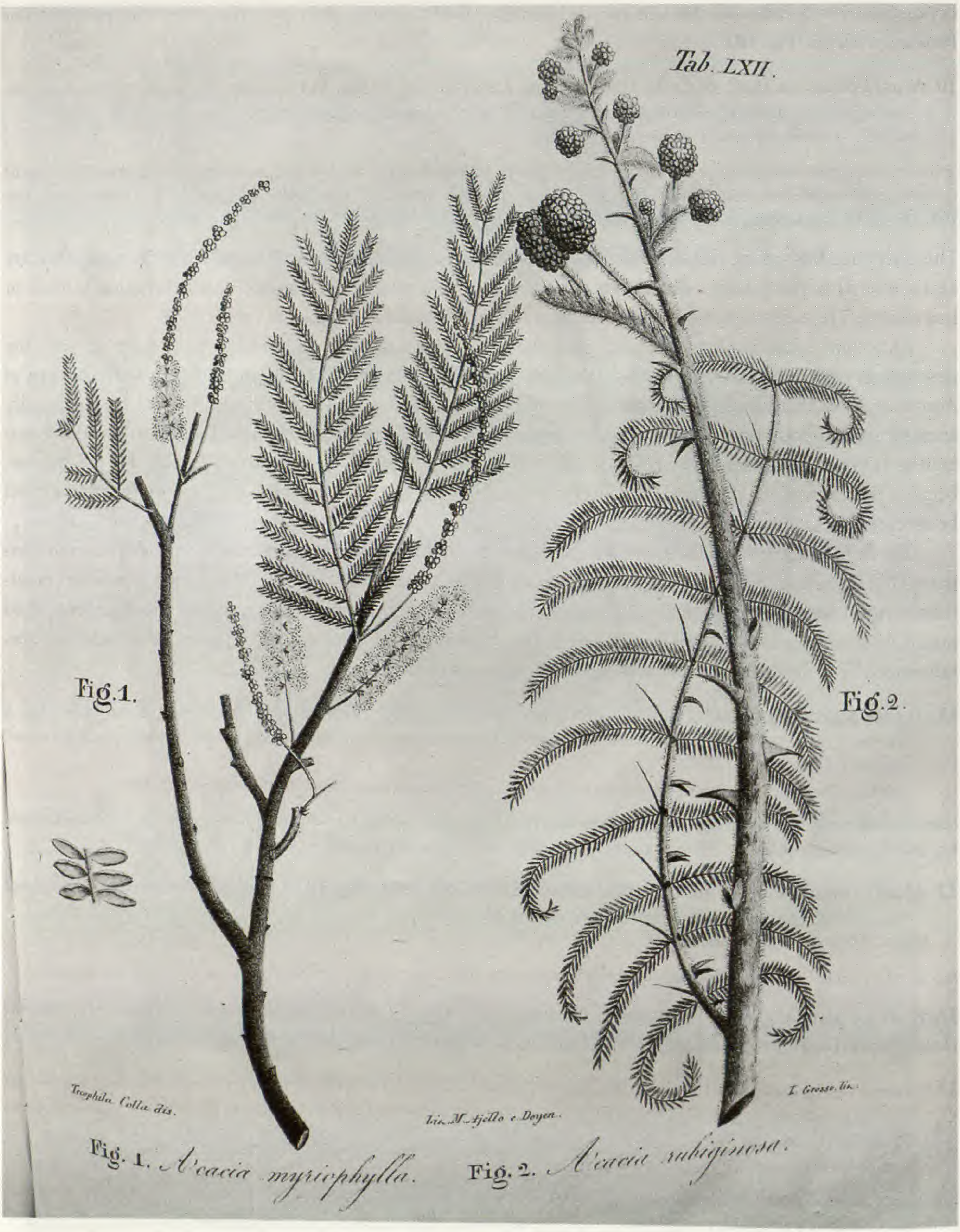

Fig. 10. Plate of *Acacia myriophylla* Mart. in Colla and *A. rubiginosa* Mart. in Colla In: L. Colla, *Herbarium Pedemontanum*, Torino, 1837, vol. 8, tab. 62.

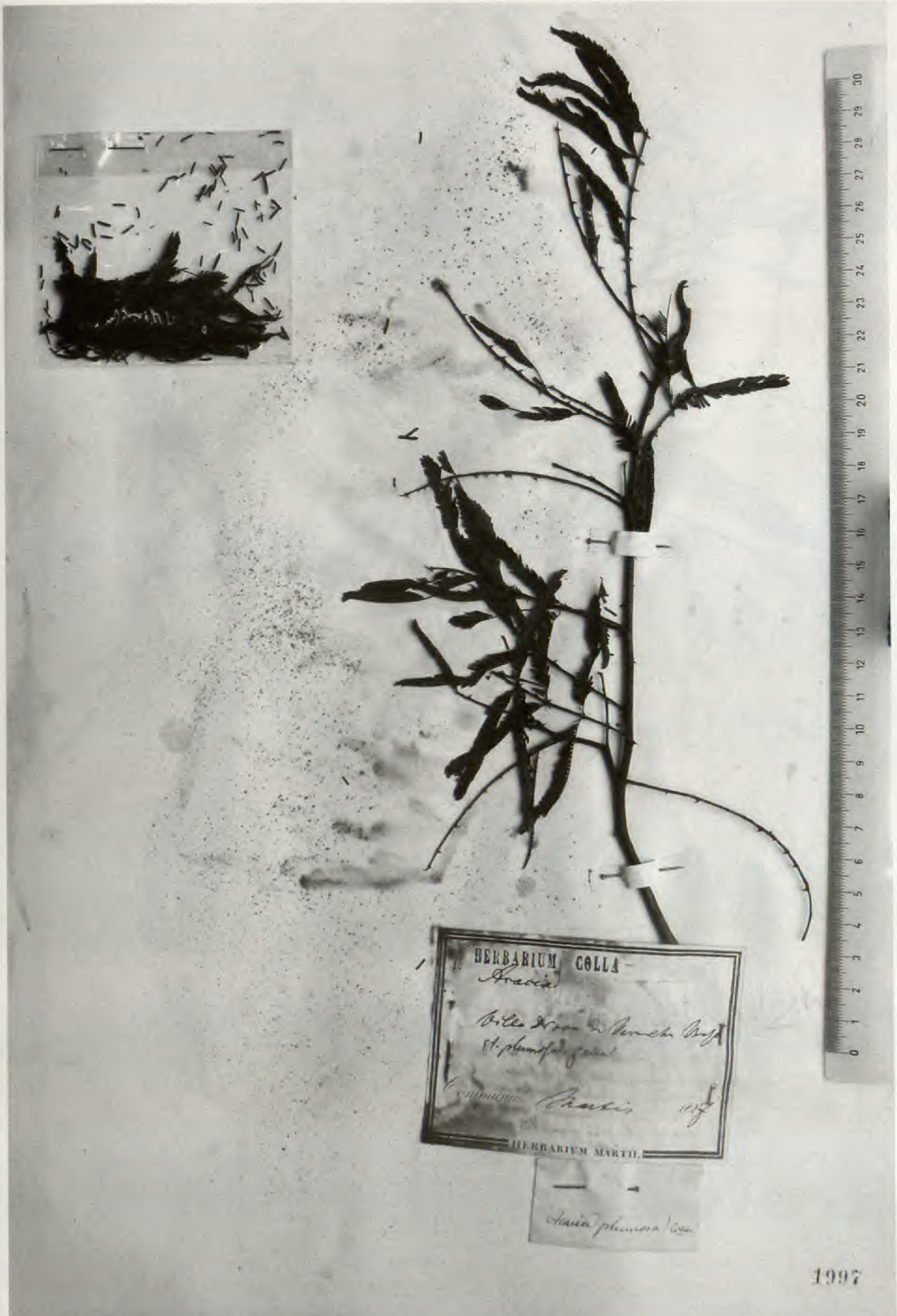

Fig. 11. Lectotype of *Acacia plumosa* Mart. ex Colla.

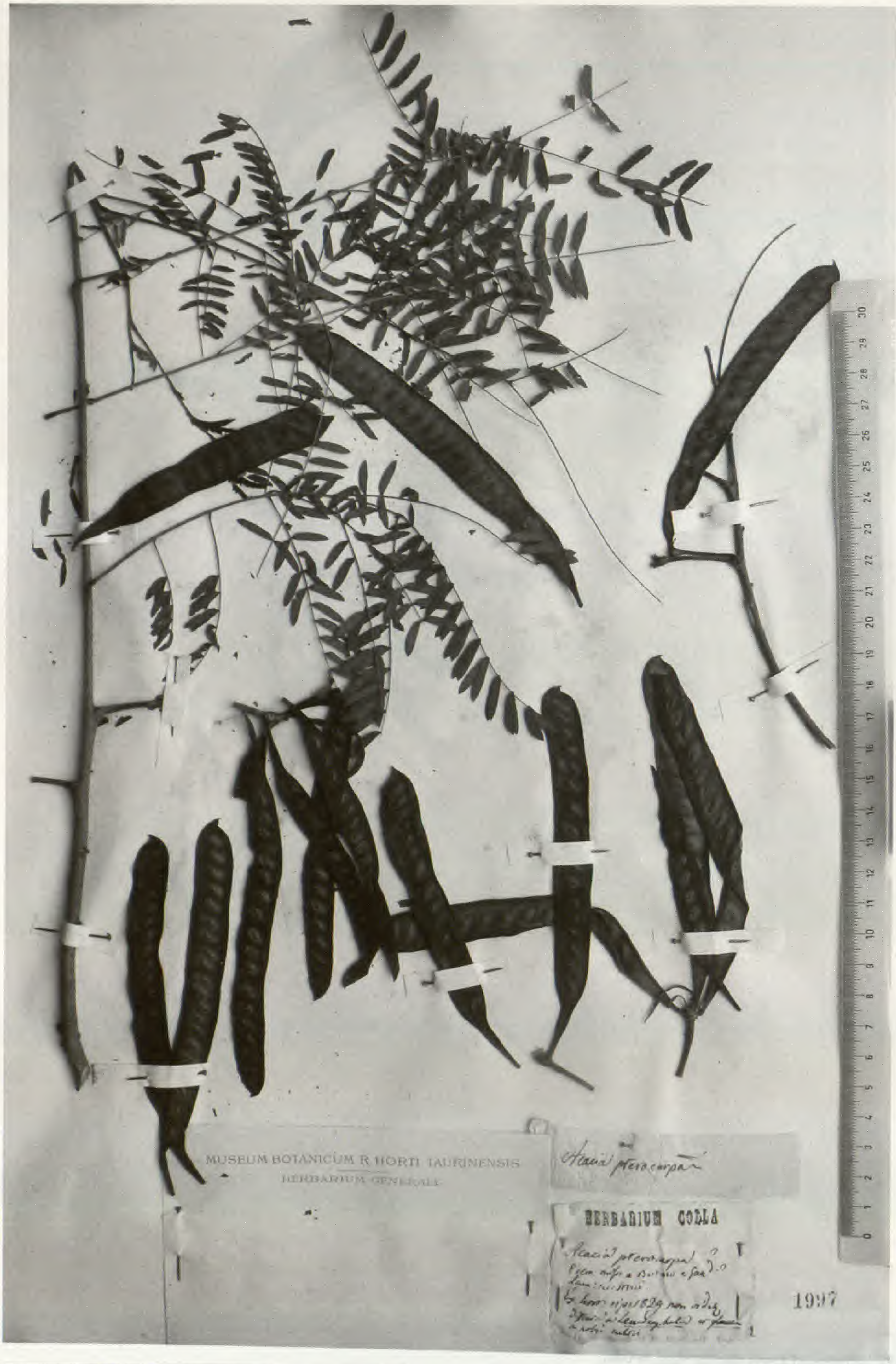

Fig. 12. Lectotype of *Acacia pterocarpa* Bertero in Colla.

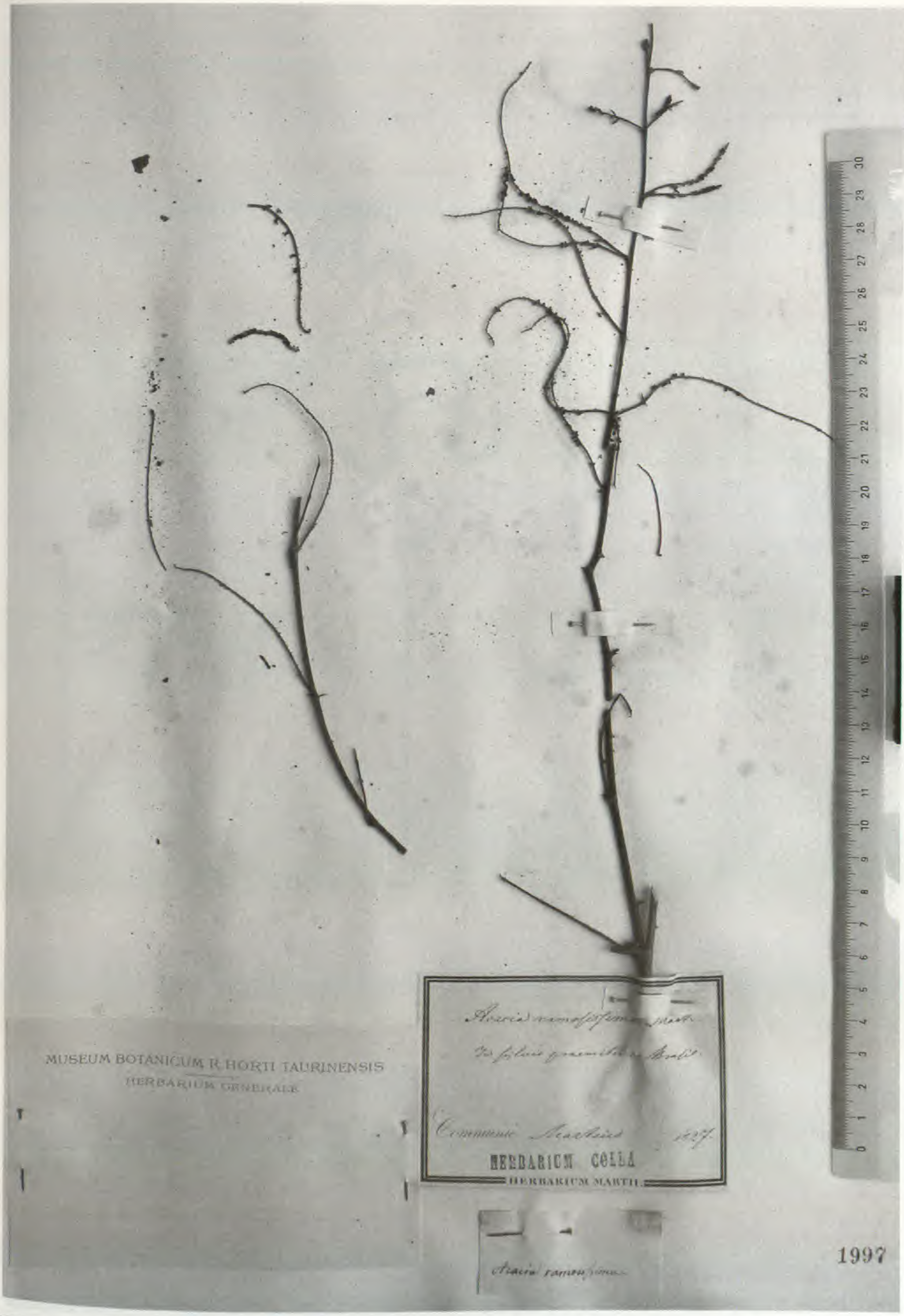

Fig. 13. Lectotype of *Acacia ramosissima* Mart. in Colla.

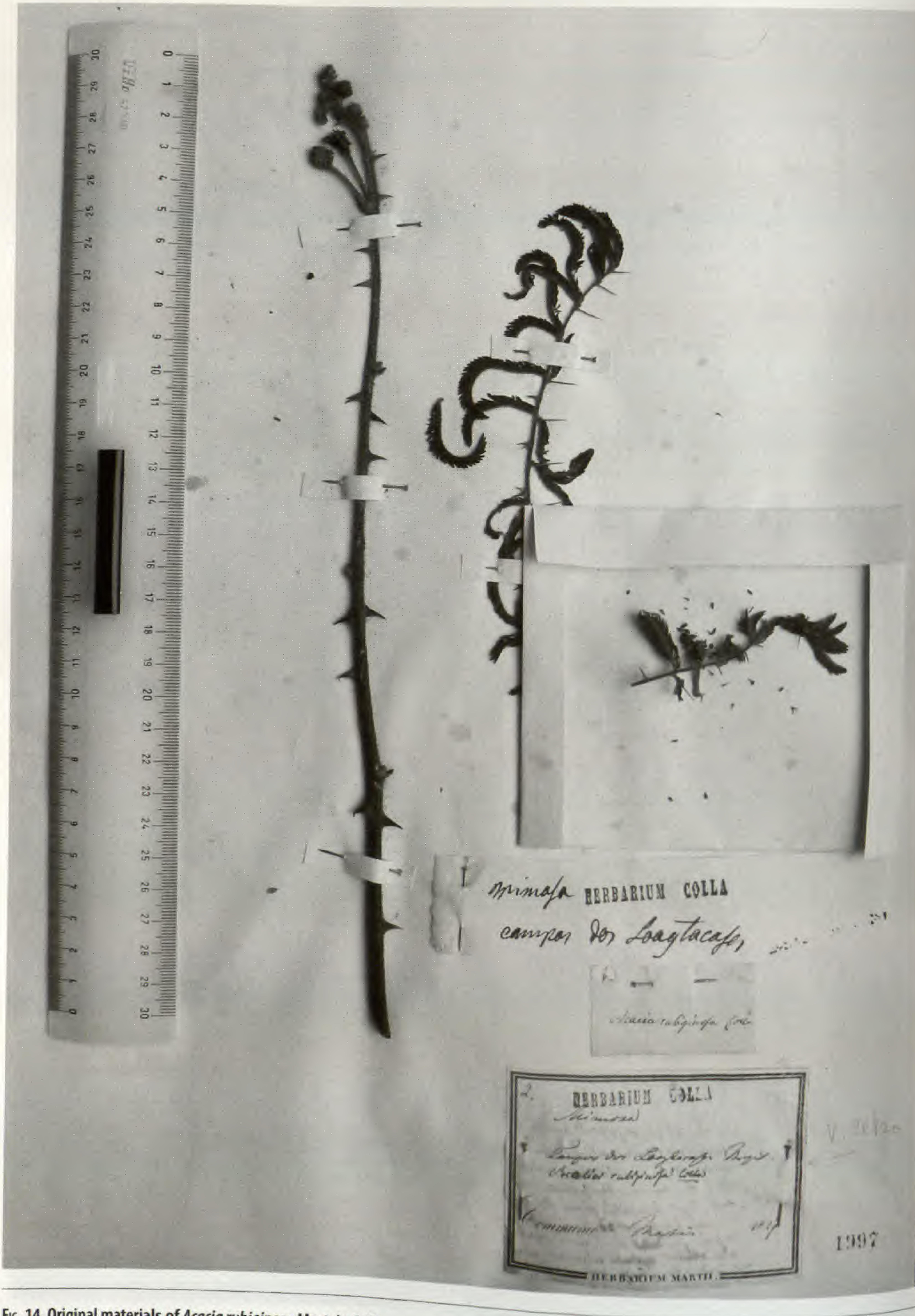

Fig. 14. Original materials of *Acacia rubiginosa* Mart. in Colla.

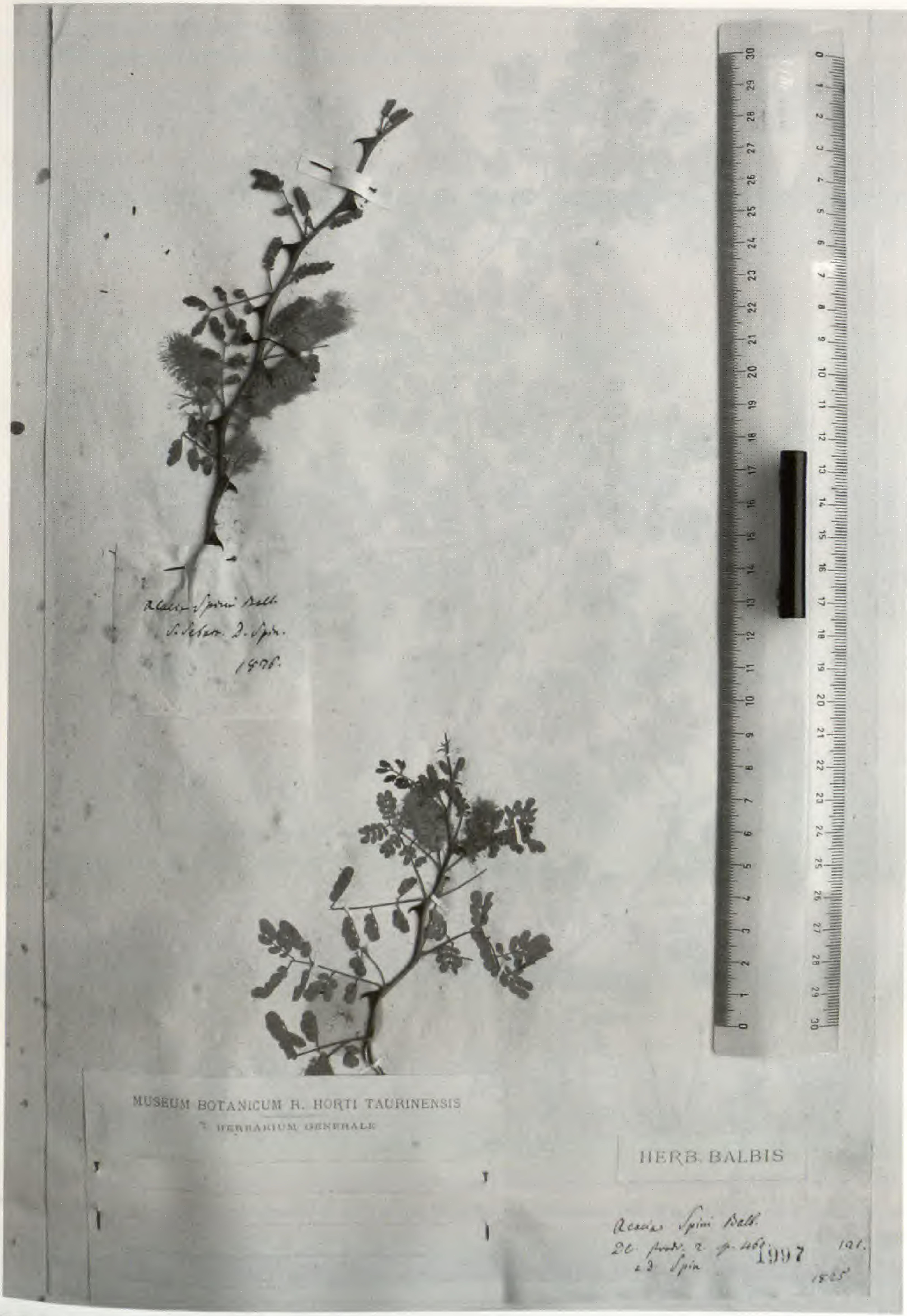

FIG. 15. Neotype of *Acacia spini* Balbis ex De Spin (upper left).

Fig. 16. Plate of *Acacia spini* Balbis ex De Spin. *Iconographia Taurinensis*. Vol. 51 (s.d.), tab. 10 (Library of Department of Life Sciences and Systems Biology, Torino).

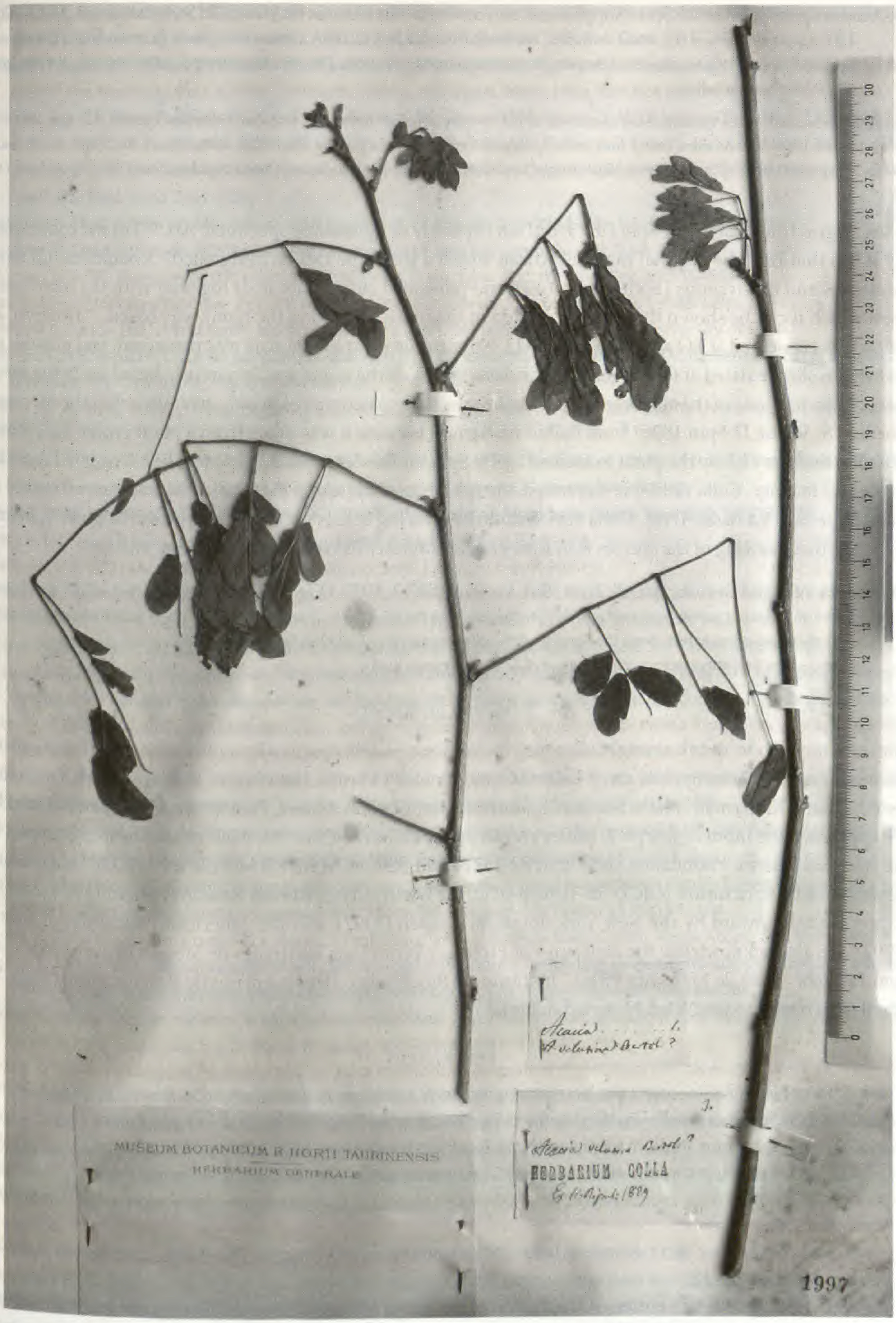

Fig. 17. Original materials of *Acacia velutina* Bertol.

14. Acacia spini Balb. ex De Spin, Supplément au Catalogue des Plantes du Jardin de St. Sébastien 8. 1823. (**Fig. 15**). *Acacia semispinosa* (L.) Willd. ex Steud., Nomencl. Bot. ed. 2, 8, 149. 1841. *Mimosa semispinosa* L., Sp. pl. 522. 1753. *Mimosa distachya* Cav. var. *oligacantha* (DC.) Barneby, Sensitivae Censitae 777. 1991. Type: "*S. Sebast. D.* Spin 1826" (neotype, here designated: TO, herbarium Balbis).

Specimens examined: Seven specimens are conserved in TO. Two are in Balbis' herbarium from San Sebastiano garden: "*D.* Spin 1825," "*S. Sebast. D.* Spin 1826" (on the same sheet); four are in Colla's collection from his garden: "*Ex H. Rip.* 1826," "*Ex H. Rip.* 1829" (on the same sheet), "*H. Rip.* Sept. 1826," "*Ex H. Rip. Oct.* 1831" (on the same sheet), and the last is in Bruno's herbarium but from Colla: "*Ex H. Ripul. Oct.* 1829."

In the original publication De Spin (1823) did not explicitly designate any specimen. Art. 9.2 of the code explicitly states that the "the original material" (from which a lectotype can be designated) "comprises: (a) those specimens and illustrations (both unpublished and published either prior to or together with the protologue) upon which it can be shown that the description or diagnosis validating the name was based..." However, all specimens conserved at TO are dated after 1823. No material prior to that date was preserved, and possibly no herbarium sheet existed at the moment of the description, as the name was apparently based on living specimens. Therefore, one of the cited specimens can be selected as a neotype of *Acacia spini*. We select the specimen labelled "*S. Sebast. D.* Spin 1826" from Balbis' herbarium because it was taken from a plant grown in S. Sebastiano Po, thus very likely the plant examined by De Spin for the description. Type locality: De Spin did not indicate any locality. Colla (1829) re-described the species and indicated that the seeds had been collected in Guadalupe near La Basse-Terre. Colla also included a drawing of this species made by his daughter T. Billotti (t. 5). Another drawing of the species is in *Iconographia Taurinensis* (vol. 51, tab. 10) (**Fig. 16**).

15. Acacia velutina Bertol., Syll. Pl. Hort. Bot. Bonon. 1827:3. 1827. (**Fig. 17**). Nom. illeg. non DeCandolle (1825). Type: Based on materials grown from seed sent by C.G. Bertero from the West Indies. Mabberley (1980, 1983) indicated that a specimen with these same data at BOLO was the type for a *Pithecellobium* species. (Colla 1834b; Bertoloni 1838).
Notes.—Now probably a heterotypic synonym of *Zapoteca formosa* Kunth.

ACKNOWLEDGMENTS

The authors wish to thank several colleagues for advice concerning questions of nomenclature and general taxonomic advice. Among these are: J. Leland Crane, Bruce R. Maslin, Fred Barrie, K.N. Gandhi, Victoria Hollowell, Duane Kolterman, Mario Sousa, Charlotte Taylor, Gordon Tucker, Paul Wilson, and James Zarucchi. We appreciate the input of Joseph T. Miller and an anonymous reviewer. We wish to acknowledge support by the National Science Foundation (NSF BSR 82-15274 and NSF-PCM 82-17114, NSF 04-15803), United States Department of Agriculture (OICD 58-319R-0-011), the University of Illinois Research Board (1994, 2001), a Rupert Barneby Award by the New York Botanical Garden (1997), and the American Philosophical Society (1992). We also acknowledge the assistance of Professor Pedro Luís Rodrigues de Moraes Universidade Estadual Paulista "Júlio de Mesquita Filho," Instituto de Biociências, Departamento de Botânica, Rio Claro, SP, Brazil with regard to von Wied-Neuwied material.

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A NOMENCLATURAL NOTE ON *BIDARIA INODORA* AND *B. TINGENS* (APOCYNACEAE: ASCLEPIADOIDEAE)

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ABSTRACT

An investigation of the nomenclature of *Bidaria inodora* (Lour.) Decne., an accepted name in the *Flora of China*, and of *B. tingens* (Roxb.) Decne., an accepted name in the *Fascicles of Flora of India*, reveals that *B. inodora* is the correct name for this taxon to be used within the genus *Bidaria* (Endl.) Decne.

RESUMEN

Una investigación de la nomenclatura de *Bidaria inodora* (Lour.) Decne., un nombre aceptado en la *Flora of China*, y de *B. tingens* (Roxb.) Decne., un nombre aceptado en los *Fascicles of Flora of India*, revela que *B. inodora* es el nombre correcto para este taxon para ser usado en el género *Bidaria* (Endl.) Decne.

In their treatment of Asclepiadaceae of India, Jagtap and Singh (1999) listed *Bidaria tingens* (Roxb.) Decne. (based on *Asclepias tingens* Roxb.) as an accepted name with *Cynanchum inodorum* Lour. as a synonym. In contrast, the Asclepiadaceae treatment in *Flora of China* (Li et al. 1995) has *Gymnema inodorum* (Lour.) Decne. (based on *C. inodorum*) as the accepted name with *B. tingens* as a synonym. Although the treatments of the Chinese and Indian floras differ in their taxonomy for this species, their different usage of epithets for the accepted name posed a puzzle and led to the following study.

Decaisne (1844) elevated *Gymnema* [unranked] b. *Bidaria* Endl. to the rank of a genus as *Bidaria* (Endl.) Decne. Within his new genus, Decaisne included five species [including *B. inodora* (Lour.) Decne. and *B. tingens* (Roxb.) Decne.]. Although he did not cite a type species for his new genus, it is automatically typified by *B. tingens*. This is because, for his infrageneric name *Gymnema* b. *Bidaria*, the basionym of *Bidaria*, Endlicher (1838) included a single species, i.e., *Asclepias tingens* Roxb., which is the automatic type species of the preceding infrageneric name.

The type species name *Bidaria tingens* is not the oldest within the genus. The priority of *B. tingens*, which is based on *Asclepias tingens* starts from 1815. The priority of *Cynanchum inodorum*, however, starts from 1790. Therefore, if *A. tingens* and *C. inodorum* are conspecific, then the correct name for this complex in the genus *Bidaria* or *Gymnema* must employ the epithet *inodora*. It is evident that the *Flora of China* (Li et al. 1995) is correct in its usage of *G. inodora*, whereas Jagtap and Singh (1999) erred in their usage of *B. tingens* as the accepted name. It is speculated here that Jagtap and Singh (1999) might have erroneously assumed that the type species name has priority over the other names. Whatever may be the reason, their error must be corrected, and the correct name within the genus *Bidaria* is *B. inodora*.

Bidaria (Endl.) Decne. in A.P. de Candolle, Prodr. 8:623. 1844. Basionym: *Gymnema* [unranked] b. *Bidaria* Endl., Gen. Pl. 595. 1838. Type species: *B. tingens* (Roxb.) Decne. (*Asclepias tingens* Roxb.).

Bidaria inodora (Lour.) Decne. in A.P. de Candolle & A.L.P.P. de Candolle, Prodr. 8:624. 1844. *Cynanchum inodorum* Lour., Fl. Cochin. 166. 1790. *Gymnema inodorum* (Lour.) Decne. in A.P. de Candolle & A.L.P.P. de Candolle, Prodr. 8:551. 1844; B. Li et al. in Fl. China 16:240, fig. 234. 1995. *Asclepias tingens* Roxb. (Hort. Beng. 21. 1814, *nom. nud.*) Pl. Coromandel 3(2):34, t. 239. 1815. *Gymnema tingens* (Roxb.) Spreng., Syst. Veg. (ed. 16) 1:844. 1824 ("1825"); Wight & Arn. in R. Wight, Contr. Bot. India 45. 1834; Hook. f., Fl. Brit. India 4:31. 1883. *Bidaria tingens* (Roxb.) Decne. in A.P. de Candolle & A.L.P.P. de Candolle, Prodr. 8:623. 1844; A.P. Jagtap & N.P. Singh, Fas. Fl. India 24:69. 1999.

The genus *Bidaria* is closely related to *Gymnema* but differs from it in having bifarous pubescent internodes and unpaired and non-bifid umbellate cymes. Additionally, the shape of the corolla and corona are different in both genera. Although Hooker (1883) treated *Bidaria* as a synonym of *Gymnema* R. Br., Huber (1973) reinstated the genus *Bidaria* which was further supported by Jagtap and Singh (1999).

As summarized above, besides making the new combination *Bidaria inodora*, Decaisne (1844) also made the new combination *Gymnema tingens*. It is uncertain whether Decaisne made the two new combinations deliberately or inadvertently. Whatever may be the fact, both new combinations were validly made and are treated as alternative names (see Melbourne Code Art. 36.2; McNeill et al. 2012).

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MICROPETASOS, A NEW GENUS OF ANGIOSPERMS FROM MID-CRETACEOUS BURMESE AMBER

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ABSTRACT

Micropetasos burmensis gen. & sp. nov. is described, based on an inflorescence of small flowers preserved in mid-Cretaceous amber from Myanmar (Burma). The flowers are ca. 1 mm in diameter, hypogynous, and have a perianth of 5 spreading, often unequal, basally connate sepals. Petals are absent. The numerous stamens have bisporangiate anthers and are of different lengths within the flower. As preserved, they are in a tight cluster appressed around the pistil. The gynoecium consists of a single carpel, whose short, curved style has an attenuate tip lacking an enlarged stigma. The pollen is triaperturate. The species has no clear affinity with a modern family, although its perianth and pollen characteristics place it within the eudicot clade Pentapetalae in phylogenetic systematics (Cantino et al. 2007).

RESUMEN

Se describe **Micropetasos burmensis** gen. & sp. nov. basado en una inflorescencia de flores pequeñas preservada en ámbar del Cretácico medio de Myanmar (Birmania). Las flores son de ca. 1 mm de diámetro, hipóginas, y tienen un perianto de 5 sépalos extendidos, a menudo desiguales, connados basalmente. Los pétalos están ausentes. Los numerosos estambres tienen anteras bisporangiadas y son de distinta longitud en la flor. Cuando están preservadas, se presentas en un grupo apresado alrededor del pistilo. El ginoecio consiste en un carpelo simple, cuyo estilo corto y curvado tiene una punta atenuada que carece de un estigma ensanchado. El polen es triaperturado. La especie no tiene yna afinidad clara con ninguna familia moderna, aunque su perianto y polen caracteristicos la colocan las eudicots en el clado de las Pentapétalas en la sistemática filogenética (Cantino et al. 2007).

INTRODUCTION

Burmese amber has been mined since AD 100, when an amber trade route was established with China. Around 1896, it was noted that the amber contained insect remains. In 2001, a new amber mine was opened in the Hukawng Valley, southwest of Maingkhwan in the state of Kachin (Poinar et al. 2005). Amber-bearing strata in this mine, known as the Noije Bum 2001 Summit Site, were initially assigned to the Upper Albian (97–110 Ma) of the Early Cretaceous on the basis of paleontological (ammonite) and palynological evidence (Cruickshank & Ko 2003). More recently, Shi et al. (2012) give an age of 98.79+/-0.62 Ma, based on U-Pb analysis of zircons from the volcanoclastic matrix of the amber. This is slightly younger than the date of 100.5 Ma assigned to the end of the Albian by the International Commission on Stratigraphy (2013, http://www.stratigraphy.org). However, Shi et al. (op. cit.) contradict themselves in claiming that the amber has not been re-deposited, yet stating that the amber occurs in marine sedimentary rocks. If the amber is in marine sediments, then it must have been re-deposited, because amber is not formed in such an environment. Just when it was first formed in a terrestrial forest is not known, leaving the true age of amber from Myanmar in question. With re-deposition, the amber must be older than the zircon-based dates determined by Shi et al. (op. cit.).

The ancient age of amber from this site is supported by the presence of primitive insects in the deposit. For example, a bee was discovered that possessed some characters of sphecid wasps, the taxon which, in traditional systematics, is considered to be ancestral to bees (Poinar & Danforth 2006). An elcanid grasshopper was also found, representing a group (Elcanoidea) that first appeared in the Early Permian and continued only to the mid-Cretaceous (Poinar et al. 2005). Thus, paleontological evidence, atomic dating, and the insect inclusions in the amber favor an early mid-Cretaceous age for mines at the Noije Bum 2001 Summit Site. In their book on early flowers of the Cretaceous, Friis et al. (2011, p. 34) propose that Myanmar amber is Late Cretaceous or Early Cenozoic; however, they provide no new evidence in support of this revised date.

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Nuclear magnetic resonance (NMR) spectra of samples taken from this locality indicate an araucarian (possibly *Agathis*) source of the amber (Poinar et al. 2007b). While insect fossils dominate (Grimaldi et al. 2002), the deposits have revealed some interesting plants, including 2 early bambusoid grasses (Poinar 2004), a staminate flower with affinities to the Monimiaceae (Poinar & Chambers 2005), an epigynous flower similar to Cornaceae (Poinar et al. 2007a), a pistillate, apetalous flower with possible connections to the rosid clade of eudicots (Poinar et al. 2008b), and an epigynous flower with characters paralleling some modern Cunoniaceae (Chambers et al. 2010, Grimaldi et al. 2002, fig. 13).

The present fossil consists of a basally bracteate fragment of a mixed cymose-paniculate inflorescence, 9 mm long (Fig. 1), whose branches bear 3–7 flowers on glabrous, relatively stout pedicels (Fig. 3). Eighteen flowers are present, but only 10 are positioned well enough for study. The perianth lacks petals, consisting of a single whorl of five basally connate sepals spreading laterally at anthesis (Fig. 2). The calyx lobes may be equal or unequal in size. The numerous stamens are tightly clumped around the pistil, perhaps becoming aggregated during preservation in the resin. On four flowers, 1 or 2 unusually long stamens are visible, separate from and external to the others (Figs. 2, 3), and some of these appear to have a broadened, ribbon-like filament (Fig. 2). The gynoecium consists of a single carpel bearing a short, curved, attenuate style, the ovary being mostly hidden by the surrounding mass of stamens (Fig. 3). Among eudicot flowers thus far described from this period (Friis et al. 2006, 2011), *Micropetasos* is distinctive in its combination of five connate, spreading sepals, no petals, numerous stamens with bisporangiate anthers, and a gynoecium comprising a single, superior carpel with an arcuate, attenuate style.

MATERIALS AND METHODS

The fossil inflorescence is preserved in a quadrilateral piece of amber with sides of 20, 15, 11, and 10 mm, which initially was part of a larger piece containing a fossil scorpion. It is in the amber collection of J. Wunderlich, Oberer Häuselbergweg 24, Hirschberg, Germany 69493, and will eventually be deposited in the Senckenberg Museum and Research Institute, Frankfurt-am-Main. The amber was obtained from the Noije Bum 2001 Summit Site in the Hukawng Valley, Burma, as described above. Examination and photography were made with a Nikon stereoscopic microscope SMZ-10R at 80X and a Nikon Optiphot microscope at 800X.

DESCRIPTION

Micropetasos G.O. Poinar, K.L. Chambers & J. Wunderlich, gen. nov. Type Species: *Micropetasos burmensis* G.O. Poinar, K.L. Chambers & J. Wunderlich.

Flowers small, in groups of 3–7 on branches of a basally bracteate, glabrous, mixed cymose-paniculate inflorescence (Fig. 1), pedicels relatively stout, glabrous, ebracteate (Fig. 3), flowers bisexual, hypogynous, calyx 5-merous, regularly or irregularly actinomorphic, sepals glabrous, basally connate, lobes triangular, obtuse or acute, equal or unequal (Fig. 2), petals none, stamens numerous, bunched around the pistil (Fig. 3), filaments linear, short on outer stamens, longer on those near the pistil, sometimes 1–2 outer filaments elongated (Figs. 2, 3), anthers small, oblong-ovoid, bisporangiate (Figs. 2, 3), connective not prolonged, gynoecium of 1 carpel, ovary conic or ovoid (hidden by the mass of appressed stamens), disc or nectaries, if any, not visible, style short, arcuate, attenuate, stigmatic area terminal, papillate, not enlarged.

Micropetasos burmensis G.O. Poinar, K.L. Chambers & J. Wunderlich, sp. nov. (**Figs. 1–4**). Type: MYANMAR (Burma). Kachin: Noije Bum 2001 Summit Site amber mine in the Hukawng Valley, SW of Maingkhwan, 26°20'N, 96°36'E, 2012, *unknown amber miner s.n.* (holotype: accession no. F2469/BU/CJW, deposited in the amber collection of J. Wunderlich, Hirschberg, eventually to be deposited in the Senckenberg Museum and Research Institute, Frankfurt-am-Main, Germany).

Flowers 0.8 mm in diameter at anthesis, connate portion of calyx 0.13 mm, lobes 0.26–0.30 mm, stamens 60+, filament length variable, anthers 0.06–0.10 mm, ovary 0.51 mm long, 0.38 mm wide, style 0.18 mm, pedicels 0.26–0.64 mm, pollen triaperturate (Fig. 4), diameter 10–14 µm.

Etymology.—Genus name from the Greek "micro," small, and "petasos," broad-brimmed hat, from the imagined shape of the flowers at anthesis. Species name from the country of origin of the fossil.

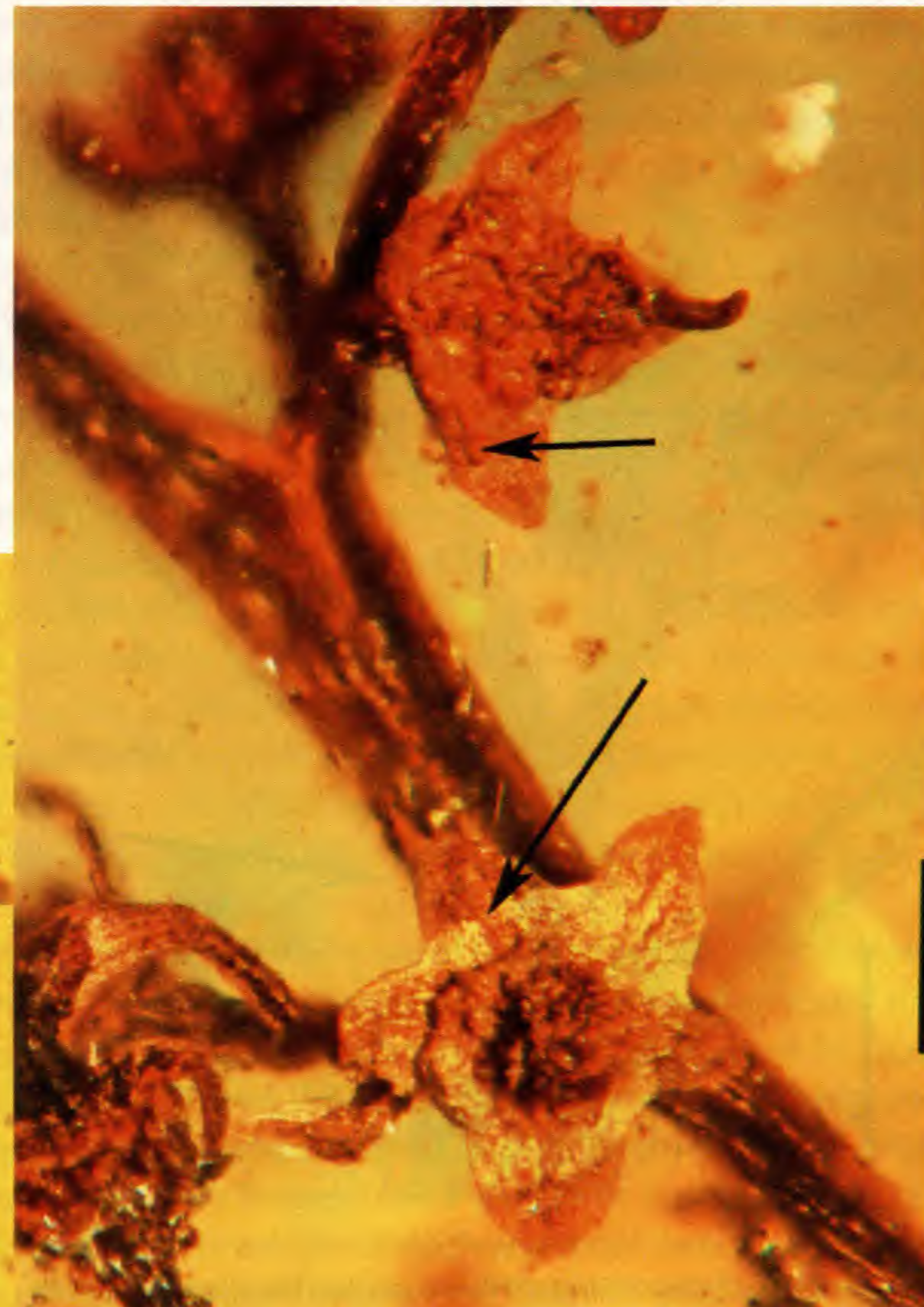

Fig. 2. ***Micropetasos burmensis*****. Two flowers in lateral and apical view. Upper arrow shows an anther of a long stamen lying against a calyx lobe. Lower arrow is on a ribbon-like filament of a long outer stamen. Note varying sizes of calyx lobes. Scale bar = 0.31 mm.**

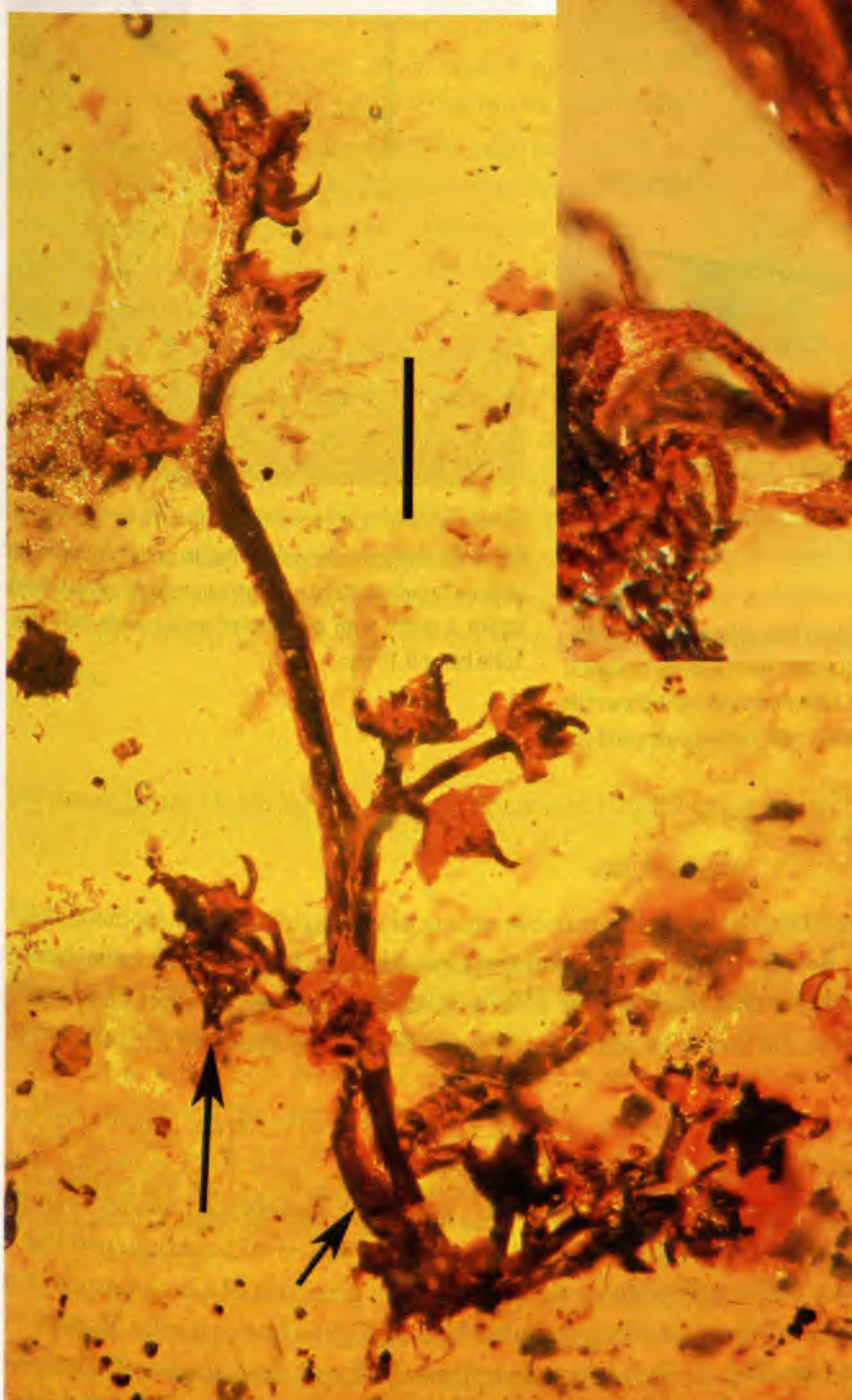

Fig. 1. ***Micropetasos burmensis*****. Entire inflorescence. Left arrow points to an aberrant carpel with 2 styles. Right arrow is on a single bract at the base of the inflorescence.. Scale bar = 1.2 mm.**

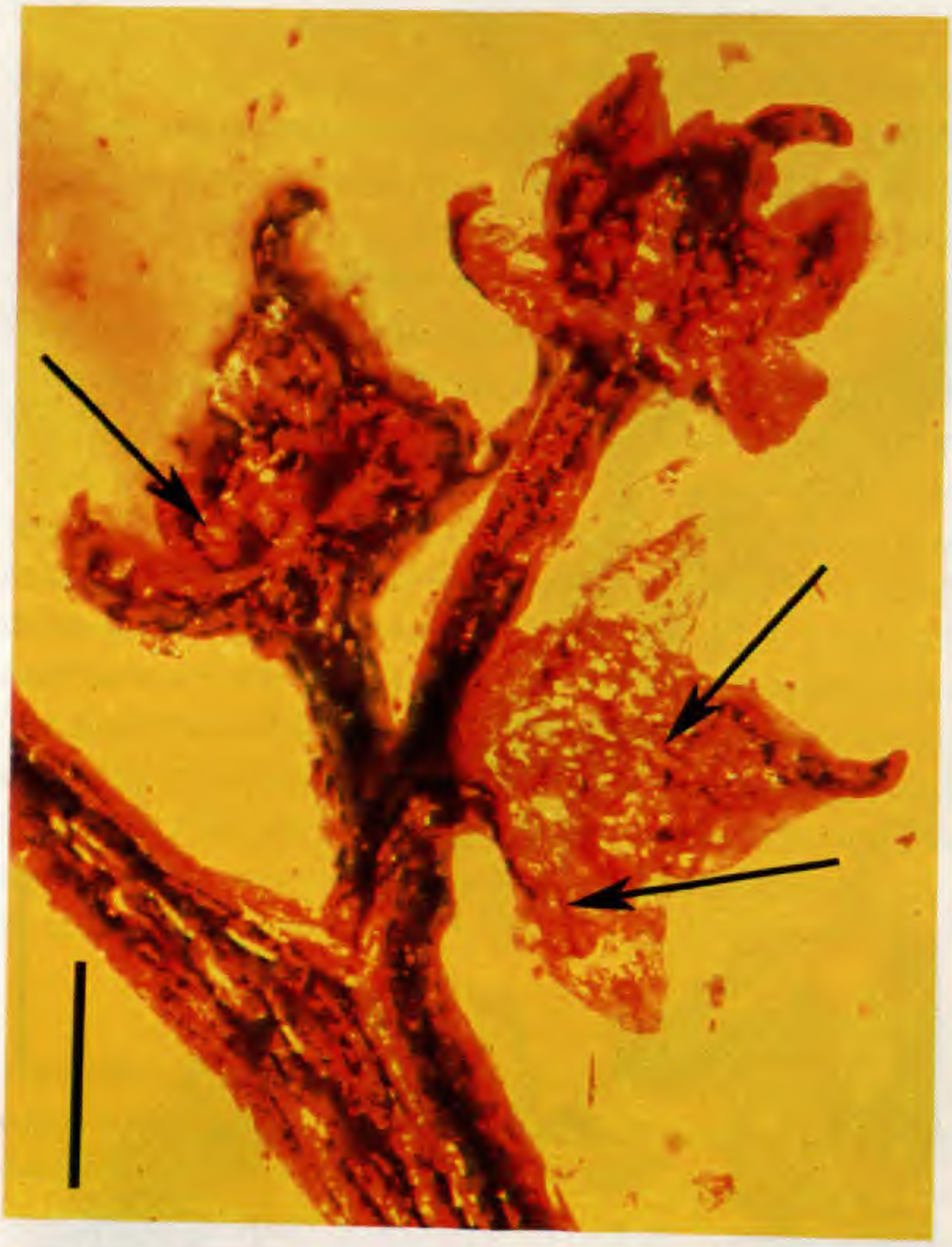

FIG. 3. *Micropetasos burmensis*. Group of 3 flowers on a short lateral branch of the inflorescence. Left arrow points to anther of a short outer stamen. Middle arrow at right is on a mass of long inner stamens appressed to the pistil. Lower arrow at right shows the linear filament of an elongated outer stamen. Note pistils with curved styles and the stout floral pedicels. Scale bar = 0.38 mm.

FIG. 4. *Micropetasos burmensis*. Pollen grains on surface of stigma. Arrow points to a triaperturate grain with contents intact. 4 grains with germinated pollen tubes are below. Scale bar = 0.16 mm.

DISCUSSION

In some modern families with a single superior carpel, such as Fabaceae, a curved style may be associated with an overall zygomorphic symmetry of the flowers. However, in *Micropetasos* the style does not arch consistently toward the largest or the smallest calyx lobe, and the stamens evenly surround the pistil rather than being displaced to one side. We therefore describe the flower as actinomorphic, although it is bilateral with respect to the pistil.

Interpretation of the androecium is difficult because the stamens appear to be of different lengths and the longer, inner ones have adhered to the pistil, perhaps as an artifact of preservation. The shorter, outer stamens on several flowers, although closely packed, are free from each other, and their undehisced anthers can be distinguished (Fig. 3). Anthers of the longer stamens have mostly given up their pollen and are flattened into a formless mass (Fig. 3). An irregular feature of the androecium is the occasional presence of a long stamen outside the main group, either lying against the calyx or standing upright (Figs. 2, 3). In a few cases the filament of these stamens is broadened and ribbon-like (Fig. 2). It is interesting that the fossil described as *Paleoclusia* (Crepet & Nixon 1998) also had stamens of unequal lengths, grading from short outer to long inner (op. cit., Fig. 6). The stamens of this species were fascicled, however, and the gynoecium was 5-carpelled with sessile, peltate stigmas, petals were present, and the sepals appear to have been free.

An irregularity in the gynoecium is present in one flower of *Micropetasos*, where two styles are present, one short, straight, and appressed to the usual longer, curved one (Fig. 1). In is unclear whether this indicates a fully bicarpellate gynoecium. Our ability to detect these kinds of developmental variations is due to the rare example of a fossil in which several flowers of the species are connected in an inflorescence, as contrasted to the usual case where flowers are detached and only one or two can be assigned to the same taxon (but see Poinar et al. 2008a and Chambers et al. 2012, where six and four flowers, respectively, were available). In an example cited by Friis et al. (2011, p. 32), two coalified fossil flowers of *Lasistemon*, male and female, could be associated through the presence, in both, of pollen having a distinctive exine pattern. From the example of *Micropetasos*, one might speculate that floral development was more flexible, i.e. less canalized, in the early evolution in some angiosperm clades, but that this has gone undetected because the descriptions of fossil taxa have commonly been based on one or a few flowers. In deposits of coalified or lignified flowers, where large numbers of specimens are collected together (Friis et al. 2011), it is possible that this drawback can be overcome.

The consistent curvature of the style, together with the relatively stout floral pedicels of *Micropetasos*, may have been associated with insect pollination, especially given the small size of the flowers. The presence of pollen grains on the style and calyx but not in the surrounding amber suggests that the grains may have been adhesive. This feature would facilitate attachment to the body of visiting insects. Small insects would be the most likely pollinators of minute flowers such as those of *Micropetasos burmensis*. *Melittosphex burmensis*, a tiny bee just less than 3 mm in length that lived in the Burmese amber forest (Danforth & Poinar 2011), is a possible candidate.

A possible relationship of *Micropetasos* with a modern family in one of the redefined clades of eudicots (APGIII, Stevens 2001 onward) is problematic. Features such as hypogyny, a connate calyx, numerous stamens, a single carpel, and a curved style are suggestive of certain members of the Fabaceae. However the similarity is only superficial, because the inflorescence differs from the racemose type found in that family, and numerous stamens occur principally in the highly derived subfamily Mimosoideae. Furthermore, molecular phylogenetic studies date the origin of Fabaceae to the Early Tertiary (Lavin et al. 2005). In terms of phylogenetic systematics, *Micropetasos* appears to represent an early member of the Pentapetalae clade (Cantino et al. 2007), also known as core eudicots. We prefer to leave the question of its exact familial relationships open at this time.

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DR. PUGH'S HERBARIUM

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ABSTRACT

Evan Pugh, a young and talented agricultural chemist from Pennsylvania, produced important discoveries on the role of plants in the fixation of atmospheric nitrogen during three years of study and research, conducted in England from 1856–59. He then returned home as the first president of what is now the Pennsylvania State University, not only the youngest, but also the most talented president the institution has ever had. Arriving in 1859 to take up his new duties, he brought with him plant specimens he had collected during a several months' visit to the Heidelberg area of Germany in 1856, and also much of the herbarium of Professor G.W. Bischoff of Heidelberg, which he bought while there. It is clear that Pugh wanted the new college to become an important center for agricultural research and thought a herbarium was an essential asset for such research. Pugh died in 1864, but W.A. Buckhout, a student of Asa Gray at Harvard, took over botany, horticulture and the responsibility for the Pugh herbarium at Penn State in 1872. The intimate connection between that herbarium and the founding of a university is unique.

RESUMEN

Evan Pugh, un inteligente joven químico agrícola de Pensilvania, produjo importantes descubrimientos en el papel se las plantas en la fijación del nitrógeno atmosférico en tres años de estudio e investigación, realizada en Inglaterra durante 1856–59. Entonces regresó como el primer presidente de lo que ahora es la Universidad Estatal de Pensilvania, siendo no solo el más joven, sino también el presidente más inteligente que la institución haya tenido. Llegó en 1859 para emprender sus nuevos deberes, trajo consigo especimenes de plantas que había colectado durante la visita de varios meses al área de Heidelberg en Alemania en 1856, y también gran parte del herbario del Profesor G.W. Bischoff de Heidelberg, que compró mientras estaba allí. Está claro que Pugh quería que la nueva universidad se convirtiera en un centro importante de investigación agrícola y pensó que un herbario era un activo esencial para tal investigación. Pugh murió en 1864, pero W.A. Buckhout, un estudiante de Asa Gray en Harvard, se quedó a cargo e la botánica, horticultura y la responsabilidad del herbario Pugh en la Penn State en 1872. La conexión íntima entre el herbario y la fundación de una universidad es única.

BACKGROUND

In 1868, the new Pennsylvania College of Agriculture in Centre County (now the Pennsylvania State University) was in pitiful condition. The tragic death in 1864 of the young, very talented first president, Evan Pugh, and the departure of many of the students for the American Civil War in 1863–65 were nearly fatal to the infant college. The administration called for an inventory of everything of value that the college possessed. On the not especially noteworthy list was "Dr. Pugh's European Herbarium" (Fig. 1).

The original heart of the Penn State Herbarium, Dr. Pugh's collection still exists and is now located in 13 Whitmore Lab. Aside from the old Presidents' House, which Pugh partly financed from his own pocket, and the construction of which he oversaw right up to his death, the Pugh herbarium is the most personal relic of Evan Pugh's presence here, other than some boxes of his correspondence and a handful of books from his library, which are in the Penn State Archives.

Pugh's herbarium is not only still extant, it is in constant use, expanded from the approximately 3,000 original specimens from Pugh to 107,000 now. It is known in the scientific literature, as are all herbaria recognized by *Index Herbariorum* (Thiers 2008) by an acronym, in this case, "PAC," for Pennsylvania Agricultural College. That is approximately the same name used on the labels in Dr. Pugh's herbarium, "Agricultural College of Pennsylvania," which Pugh substituted for "Farmers High School," the name of the institution founded in 1855 that he took over in 1859.

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Page from the Pennsylvania Agricultural College
Inventory of January , 1868.

One Articulated Skeleton, and one Loose Skeleton, for Instruction in Human Anatomy and Physiology,
Diagrams to Illustrate Human Anatomy and Physiology,
Dr. Pugh's European Herbarium,
An Air Pump, Electrical Machine, &c.,
A very good assortment of Apparatus and other Appliances for Class-room and Laboratory Instructions in Chemistry,
A Surveyor's Compass, Chains and Pins,
A Rail Road Transit Rail Road Level and Graduated Staff,
The use of Prof. James Clark's private Zeological Collection,
A Mason & Hamin's Organ,

Fig.1. Page from the 1868 emergency inventory of the possessions of the Pennsylvania College of Agriculture. Dr. Pugh's herbarium (see arrow) was obviously regarded as a significant asset.

It is clear from Pugh's correspondence that he wanted the new college in rural Pennsylvania to become an important center for agricultural research, and he regarded a herbarium as an essential asset for the aspects of such research that depended on a breadth of botanical knowledge and information. His herbarium is also more personal than the house he built but never lived in, since he obviously handled each and every plant specimen that he collected, purchased, or otherwise obtained while in Heidelberg, Germany, in the spring and summer of 1856. Among other things, the Pugh specimens demonstrate dramatically the durability of herbarium specimens. Despite the many vicissitudes of the collection in Germany, the voyage to America, and the early days at Penn State, most of the Pugh plants remain in excellent condition (Fig. 2).

Especially noteworthy in this connection are some specimens that Pugh obtained from the herbarium of G.W. Bischoff, Professor of Botany at Heidelberg. They survived collection in various parts of the world, shipping to Germany and then shipping again to the rather primitive environment of Centre County, Pennsylvania, to a nascent institution in open farmland, fifteen miles from the nearest city, with no finished building to receive the pressed plant collection.

Evan Pugh was not only the first president of what became Penn State University, he was also the youngest and unquestionably the most talented president the institution has ever had (Fig. 3). Had he not died at the early age of 36, it is certain that his impact on American education and science would eventually have rivaled that of the legendary American college presidents of the 19th century, luminaries such as Charles W. Eliot of Harvard. In science, his biochemical work in Germany, and especially in England, on the fixing of nitrogen by plants, was widely acclaimed. His early correspondence as president of the nascent Pennsylvania college shows that he was having an impact in the political/educational arena of America. For example, he persuaded others of the importance of the developments leading to the Morrill Act of 1863, which set up a funding system for what became the "Land Grant Colleges." This was most dramatically displayed in Pugh's actions in assuring that the funds accruing to education in Pennsylvania from the Act would go to Penn State and only to Penn State.

On one of the sheets of a herbarium specimen Pugh collected in Heidelberg, he noted that the specimen was "collected for W. H. Brewer." Brewer and Pugh were in Heidelberg at the same time—the summer of 1856—and both did extensive botanizing that summer in central Europe. Brewer later became head of the Agricultural Department at the Sheffield Scientific School at Yale, but at the time Pugh arrived at the nascent

FIG. 2. One of Evan Pugh's collections from the Heidelberg area in the summer of 1856 and next to it (right), a specimen of the same species (*Lathyrus pratensis* L.) collected by a German botanist, Ulrich Kull, in the same province of Germany in 2012, illustrating the durability of herbarium specimens, even over 157 years of rather challenging experiences—providing the specimens are kept dry and protected from cellulose-consuming events and animals.

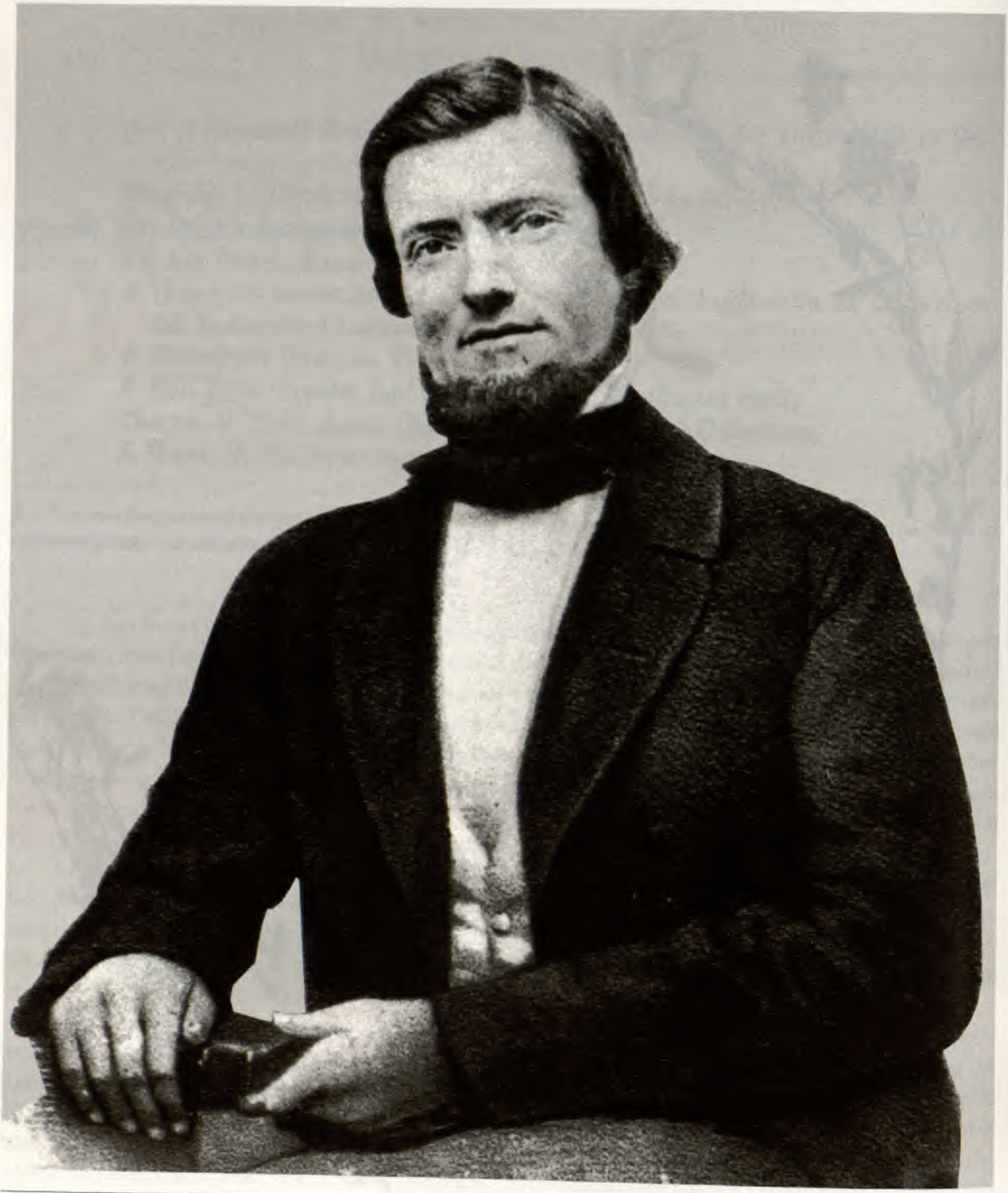

FIG. 3. Dr. Evan Pugh, Penn State's first president, as he looked at the time he arrived back in Pennsylvania from his years in Europe, in 1859. He was a big man, well over six feet tall.

Penn State in 1859, Brewer was Professor of Chemistry at what is now Washington and Jefferson College in Washington, Pennsylvania. Brewer was an outstanding scientist. Presumably he and Pugh remained in close touch back home in Pennsylvania, for example, on such matters as the move toward the Morrill Land Grant legislation.

Pugh was a chemist, but one whose interests were broad, and whose most important research was con-

nected to plants. His early education, through what we would consider high school, was in various private schools in eastern Pennsylvania and New York, with heavy emphasis on languages, mathematics, and the sciences. He then taught in an elementary school and subsequently became principal of an academy, both in the Philadelphia area. By 1853, at age 25, he had inherited a considerable fortune and was able to travel to Europe and spend the next three years at the German universities of Leipzig and Göttingen.

After completion of his doctoral dissertation, which dealt mostly with mineralogical chemistry, at Göttingen in early 1856, he accepted a research position in the renowned laboratories at Rothamsted Experimental Station, England, where he worked for several years, beginning in the Fall of 1856. He made significant discoveries there, showing that certain plants can take nitrogen from the atmosphere and incorporate it into their chemical structure. This is a critical matter to Earth's biochemistry, as it explains how plants can produce proteins independently from those they can absorb from the soil. It has been suggested that if research of such significance were published today, the author would likely get a Nobel prize or share one with co-authors. The critical paper was Lawes, Gilbert and Pugh, 1862. Pugh was invited to lecture on this research by the British Chemical Society and was made a fellow of the Society in reaction to the significance of his discoveries. Later, the importance of his early scientific work was overshadowed by his accomplishment in turning "Farmers High School" into the forerunner of the great American Land Grant universities. Over the years, the great significance of his work with plant fixation of nitrogen has occasionally been noted in the literature (e.g., Browne 1930).

During the Spring and Summer of 1856, before Pugh went to Rothamsted, he spent several months in Heidelberg. Why he went there is not certain. A letter home commented that his laboratory in Heidelberg was the best he had ever had in Germany and that he loved the countryside around this storied University. The chief chemist there at the time was Robert W. E. Bunsen of Bunsen-burner fame, but I have found no evidence that Pugh worked with him. One thing is certain about Pugh's time in Heidelberg: he did much plant collecting and was in contact with the botanical personalities of that time and place. It seems likely that the purpose of the sojourn in Heidelberg was botanical. Pugh would certainly need to enrich his botanical knowledge to accompany his mastery of chemistry, to be prepared for work at an agricultural college in the mid-19th century. Producing a herbarium would be an important part of what he took back to America from Europe. Many of the plants for this purpose were collected by Pugh himself in parts of Baden-Württemberg near Heidelberg. Furthermore, and very important, is that one of the leading botanists in Germany of the time, G.W. Bischoff (1797–1854), was Professor of Botany at Heidelberg University and Director of the Heidelberg Botanical Garden. Bischoff died not long before Pugh had finished his doctorate at Göttingen and headed for Heidelberg. Bischoff's herbarium was sold at auction in Heidelberg on 21 July 1856, and Pugh bought a considerable part of it. Those plant specimens, for the most part clearly marked with both Bischoff's and Pugh's names, plus Pugh's own collections of 1856 from the Heidelberg area—including a number from the famous Heidelberg Botanical Garden—plus many specimens that he somehow obtained from other German collectors, make up "Dr. Pugh's European Herbarium" that he shipped to America (Figs. 2, 4–7).

One significant aspect of "Dr. Pugh's Herbarium" is that Heidelberg's Professor Bischoff was a prodigious collector of plants, having made collecting forays from about 1820 to about 1850 to various parts of the world—South Africa, South America, etc. On at least two of his trips he collected in or near Pennsylvania. There are a number of sheets in the Pugh herbarium with labels indicating that the specimens were collected in the vicinity of Reading, Pennsylvania, in 1831 and in New Jersey in 1849 (Figs. 5, 6 & 7). (Coincidentally, Evan Pugh was born and raised in Oxford, a small rural town in southeastern Pennsylvania, less than 50 miles south of Reading and the same distance west of New Jersey.) The American Bischoff specimens would have crossed the Atlantic with Bischoff to Europe in a sailing vessel, and then after some years in the botanical collections in Heidelberg, been bought by Pugh in 1856, and shipped back across the Atlantic, this time probably by steamship, eventually ending up in the Penn State Herbarium.

In one of his letters, Pugh mentioned shipping a crate of rocks and minerals from Göttingen to relatives in the Philadelphia area, presumably samples from his Ph.D. work. It seems probable that he arranged the same

Fig. 4. Typical example of the herbarium specimens purchased by Pugh in 1856 from the estate of the prominent Heidelberg botanist, Prof. G.W. Bischoff. Note that Bischoff's label, on the left, is written in an outmoded form of German handwriting, not used since the 1930s. The specimen is a fern from Tyrol, Austria, collected by Bischoff in 1823.

FIG. 5. Herbarium specimen of a fern collected by Bischoff in Reading, PA, in 1831. PAC has many such specimens that crossed the Atlantic with Bischoff enroute to Germany, then back across it in 1859, with the rest of Pugh's herbarium.

Fig. 6. Specimen of a fern collected by Bischoff in 1849 on one of his many foreign collecting trips. Original label in Bischoff's easily recognized handwriting, upper left. "Novae Caesarae" is the genitive form of Nova Caesarea, the name of New Jersey in Latin. Dr. Pugh's herbarium included hundreds of Bischoff plants from over much of the world: South Africa, South America, Cuba, Java, etc.

FIG. 7. Specimen of an orchid collected by Pugh in the Spring of 1856, in the Baden-Württemberg area, when he was obviously very busy expanding coverage of his herbarium. Note that the label, ostensibly by Pugh, is actually a reworking of Pugh's data in about 1875, by W.A. Buckhout, when he was Head of the Department of Botany and Horticulture at Penn State.

sort of shipment to Philadelphia of what would have been at least two or three large steamer trunks containing the infant Penn State herbarium. There, relatives would have been available to help him with further moving chores. Such modern-sounding shipment was apparently quite ordinary in 1856. The journey of the crates or trunks full of plant specimens from Heidelberg, probably to Rotterdam, then by sail or steamer to Philadelphia, end eventually by train to Bellefonte, Pennsylvania, and by some sort of horse-drawn vehicle the last ten miles or so to State College, before there even was a State College or a significant road to the area, is fascinating to contemplate.

EVAN PUGH AT THE PENNSYLVANIA AGRICULTURAL COLLEGE

Dr. Pugh arrived in Centre County in 1859 to head up the Farmers High School, which he soon renamed Agricultural College of Pennsylvania. (It became Pennsylvania State College in 1874 and Pennsylvania State University in 1953.) Pugh's first job was to rescue the then floundering agricultural college, beginning with securing funding for completion of the first, and for some time only, permanent building, the original Old Main. The herbarium would have been kept in that building, which also provided classrooms, laboratories, dormitories, refectory, and so on. It was constructed of Ordovician dolomite, quarried near the building. Students provided much of the labor as part of their program. The ground plans for the structure show several small rooms labeled "Museum." Presumably, the herbarium would have been kept in one of those rooms.

Evan Pugh died in 1864, some weeks after he had a disastrous buggy accident in the Bellefonte area, in which one of his arms sustained multiple fractures, which were mismanaged locally. He then went to Philadelphia, where the bones were reset. Not long afterwards, back home, he died of a fever, frequently referred to as typhoid; it seems more likely that sepsis from the mangled arm was responsible.

THE HERBARIUM SINCE PUGH'S DEATH

Soon after Pugh's tragic death, there was a student in the college named William A. Buckhout, who had a keen interest in plants and the science of botany. In 1869–1870 he studied at Harvard with Asa Gray, at that time the most renowned American botanist. In the herbarium there is still a small collection of ancient photos of the great man, certainly keepsakes that Buckhout brought back to Penn State from Cambridge, when he returned in 1871 to become head of the infant Department of Botany and Horticulture. He remained in charge of plant research and teaching at Penn State until his death in 1911 (Fig. 8). Buckhout did not collect many plant specimens for the herbarium, which was a unit of his department. However, one of the collections he did make was of a maple (Fig. 9). That specimen has been important in tracing one aspect of the history of "Dr. Pugh's Herbarium."

For at least sixty years, everyone connected with the Penn State Herbarium has assumed that the handwritten "Evan Pugh" on the label of every sheet of Pugh's herbarium is in fact President Pugh's signature. However, a trained herbarium curator from Guatemala, Ana Lu MacVean, at present a volunteer in the Penn State Herbarium, has begun compiling a list of all Pugh/Bischoff specimens. She inadvertently happened on the abovementioned sheet of *Acer rubrum* (red maple), collected by Dr. Buckhout in 1875, thirteen years after Dr. Pugh's death. The style of label, and the handwriting are identical to that on all of the labels in the Pugh herbarium. More research in the Penn State Archives' examples of Buckhout's and Pugh's handwriting confirms that the labels in "Dr. Pugh's Herbarium" are, in fact, the work of Buckhout. Apparently, about 1875, he decided to improve the condition of the basic Penn State Herbarium by remounting, or in some cases only re-labeling, the specimens from Dr. Pugh. In some instances, especially for the plants that Pugh had obtained from Bischoff and other German botanists, Buckhout cut the labels off the original sheets and glued them on new sheets along with the specimens; he also added a new label with the plant name and the inevitable "Evan Pugh, Heidelberg" (Fig. 6). This procedure seems to be true also for most of Pugh's own collections, although some of the specimens that he collected while in Heidelberg appear to be on the original paper, with a word or two in his own handwriting, but a label prepared by Buckhout. It is interesting that Pugh put his name on only one or two of the books from his library that Penn State still has. The lack of original signatures there and also on his botanical specimens possibly reflects his Quaker-influenced disapproval of emphasizing one's person.

Fɪɢ. 8. Dr. Buckhout as he looked around 1900. Although not primarily a plant taxonomist, he was keenly interested in the Penn State Herbarium. He personally re-labeled the entire collection.

FIG. 9. Specimen of Norway maple, collected by Buckhout in 1875. This label, made 11 years after Pugh's death, and study of Pugh's and Buckhout's handwriting in the Penn State Archives proved that all of the labels in Dr. Pugh's herbarium that appear to be the work of Pugh, as was long assumed, are in fact that of Buckhout. From slight changes in Buckhout's writing, about 1875–1880 seems to be the probable time for his re-labeling work.

Still, it is curious and not really "correct" that Dr. Buckhout failed to indicate on the sheets or apparently anywhere else, that he had so drastically altered the labeling of the specimens. He could have noted on the new labels "information transcribed by WAB/*date*" or some words to that effect. It must be emphasized in his defense, however, that his work greatly improved the physical condition of the collection. He used high-quality paper, clearly acid-free, probably pure cellulose stock. In many instances one can tell from the transferred labels that the original sheets were prepared using fair to poor paper. Buckhout also must be credited with recognizing the importance of the collection and assuring its permanence at Penn State. His emphasis on the contribution of Pugh by putting the first president's name on every sheet of "Dr. Pugh's European Herbarium" was appropriate and scientifically correct. It should also be noted that at the time of Buckhout's work, few collectors provided much information on their labels.

The existence of Pugh's herbarium, especially the Bischoff specimens, is of considerable interest to German botanists, because many of Germany's herbaria were destroyed or damaged during World War II. One Pugh herbarium specimen has already accidentally turned out to be some sort of type specimen, because all other specimens in Germany of that plant taxon have been lost. According to Professor Doctor Ulrich Kull, distinguished retired botanist from Stuttgart University, many German botanists have recently expressed astonishment that so much of Bischoff's material ended up at Penn State. That was entirely new information to them.

It is somewhat surprising that the Penn State Archives have practically nothing about the history of "Dr. Pugh's Herbarium," except for its mention in the inventory of the College's meager possessions in 1868. One can deduce that in Dr. Pugh's time and at the beginning of Dr. Buckhout's work, it will have been housed in the original Old Main. When Botany moved to the newly constructed Botany Building (now "Old Botany") in 1887, Buckhout would have moved the herbarium there, but I have found no specific mention of that event. It is a matter of living memory, that in the 20th century, when Buckhout Building was constructed to house the Biology Department, the herbarium moved there, where it occupied several different locations. In the late 20th century, it moved to various places in the Frear Building and then to its present location in Whitmore Lab.

Much of this moving can be attributed to the fact that, for some decades in the 20th century, natural history collections, including herbaria, were out of favor at universities. They were expensive to maintain and regarded as not for the most part connected to modern developments in science. However, with the realization that herbaria provide banks of DNA, the tide turned in their favor. For example, voucher sheets of pollen- and spore-bearing plants enable palynologists to check the identity of the plants from which slides of the pollen were made, and to study the DNA of the same plant.

An example of such interplay between arboreta—where living, carefully documented plants grow—and herbaria—where expertly dried and pressed, also carefully documented, plants are stored—is a living documented red maple tree (#1031) planted on the Mont Alto campus, when it was the location of the Penn State Forestry School. We have in PAC a specimen of #1031, *Acer rubrum*, in flower, containing abundant pollen, collected in 1948. It would be interesting to collect from tree #1031 again, in flower, to compare the pollen being made now with that made 65 years ago. Have the years of exposure to atmospheric pollution and/or cosmic radiation caused mutations in the tree's DNA that are reflected in the pollen size and/or fine features of the pollen wall morphology? A scientist in the Biology Department at Penn State has shown the potential richness of our herbarium records by germinating a seed from one of the Pugh plants, about 160 years old, and studying the DNA of the resulting seedling. Surely, Pugh would be gratified to know that Penn State is now developing a botanical garden/arboretum. Space will be created and designated to house the herbarium in one of the new structures planned for the arboretum.

In addition to facilitating DNA experiments, the herbarium also provides a convenient venue for paleoecologists to study plant distribution for target areas at times in the past. Our specimens range in age from near 1800 to 2013, and each specimen contains in its dried plant tissues, samples of the carbon and oxygen and other elemental isotopes from each of the represented dates and locations, a potentially rich source of information. Most specimens of herbaceous plants are collected with roots and therefore accidentally with some soil,

which soil can be analyzed in many different ways to get information about the woods of, say, Gettysburg, Adams County, Pennsylvania, in the 1800s.

PAC is a function of the Penn State Biology Department, but has no budget or other funding specifically for its work. Somehow it has survived despite this situation, because of volunteers who have recognized the value of the collection, and help from persons in the university's administration who have recognized both the historic and scientific importance of the collection. As mentioned earlier, an expert, professional volunteer, Ana Lu MacVean, is currently preparing an annotated list of all the sheets of the original, approximately 2,000 specimens of "Dr. Pugh's Herbarium," not an easy task, since they are interspersed with many thousands of other specimens. The heart of PAC is clearly "Dr. Pugh's Herbarium," and that is turning out to have not only importance as a relic of the work of Penn State's scientifically important first president, but also potential biological significance. It incorporates much of the important early 19th century herbarium of Professor Bischoff of Heidelberg University, purchased at auction by Pugh in July, 1856. Many other important collections, such as the Harshberger Herbarium of Trees and Shrubs, which came to PAC from the former Penn State School of Forestry at Mont Alto, have also, especially in recent years, found their way into the Penn State Herbarium.

It would be heartwarming if somehow PAC could be established as "The Dr. Evan Pugh Memorial Herbarium." There is nothing else at Penn State University that has so intimate a connection with the founding of the institution as does this remarkable scientific collection.

ACKNOWLEDGMENTS

Professor Dr. Ulrich Kull, University of Stuttgart, Germany, assisted the author by getting much information at the sources, about Evan Pugh's years in Europe. Paul Karwacki and Jacqueline Esposito, of the Archives Division of Penn State's library system were of great help in assisting me in use of the archival material on Dr. Pugh in the library. Ana Lu MacVean, who is preparing an annotated list of all specimens in PAC that came to Pennsylvania with Pugh in 1859, was very helpful in passing along information she encountered that was critical to my study. I appreciate the careful reviews of Robert W. Kiger (CM) and an anonymous reviewer.

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ALPINE FLORA OF CERRO QUIEXOBRA, OAXACA, MEXICO

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ABSTRACT

An annotated, vouchered checklist for a timberline plant community at the summit of Cerro Quiexobra in the Sierra Madre del Sur of Oaxaca, Mexico, is presented. Although timberlines at the summit of Cerro Quiexobra are highly irregular and sometimes poorly defined, treeless plant communities in glades and among sporadic rocky substrates from 3400–3700 m exhibit all the hallmark features of an alpine refugium: plants shade-intolerant, short-statured, and exhibiting cespitose growth habits. Cerro Quiexobra's alpine flora includes 80 known species from 28 families and 62 genera, of which 19 species are recognized as narrow endemics on the mountain's upper ridges. This observation identifies the peak as one of the richer centers of rare and endangered plant species in Mexico. Before the advent of recent and widespread fires, this plant community occupied no more than a square kilometer. However, the flora likely extended approximately 170 km across the Sierra Madre del Sur during glacial maxima, while maintaining considerable distance from alpine centers to the north (Pico de Orizaba, Veracruz) and east (Volcán Tacaná, Chiapas). Persistent isolation during the Pleistocene apparently accounts for the high rates of species endemism.

RESUMEN

Se presenta un listado florístico de una comunidad vegetal por encima del límite el bosque en la cumbre del Cerro Quiexobra, Sierra Madre del Sur, Oaxaca, México. Pese a que los límites arbóreos en la ceja del cerro son muy irregulares y a veces mal definidos, las comunidades de plantas en los claros y esporádicamente en los sustratos rocosos de 3500 a 3700 m exhiben características típicas de comunidades alpinas: plantas sin tolerancia a la sombra, de baja estatura y cespitosas. La flora alpina del Cerro Quiexobra incluye 80 especies, 28 familias y 62 géneros, de las cuales 19 especies son reconocidas como endémicas restringidas a esta montaña. Esta observación identifica esta cumbre del cerro como uno de los centros más ricos de especies de plantas raras y amenazadas en México. Previo a los recientes y extensos incendios, esta comunidad vegetal ocupaba no más de un kilómetro cuadrado. No obstante, la flora probablemente se extendía 170 km a través de la Sierra Madre del Sur durante el máximo glacial, manteniendo una distancia considerable de los centros alpinos del norte (Pico de Orizaba, Veracruz) y del este (Volcán Tacaná, Chiapas). El aislamiento persistente durante el pleistoceno explica, aparentemente, las altas tasas de endemismo.

INTRODUCTION

Alpine and subalpine vegetation is often difficult to delimit on summits or along ridges of mountains that approach timberline thresholds. Geophysical discontinuities in the angle and orientation of slopes, varying degrees of exposure to wind and solar irradiation, sporadic fires and local edaphic heterogeneity create and affect discontinuities in the distribution of timberline species and their plant communities (Billings 1974; McDonald 1993). Such is the case for alpine plant communities on the poorly explored summit of Cerro Queixobra (16°12'34"N; 96°11'51"W) in the Sierra Madre del Sur of southern Oaxaca (Fig. 1), where a species-rich association of shade-intolerant species occurs exclusively on the mountain's summit (ca. 3700 m).

The first comprehensive collections of Cerro Quiexobra were accomplished by the author in December of 1989 (*J.A. McDonald 2900-2951*) and October of 1990 (*J.A. McDonald 2987-3040*), followed by significant expeditions by Jaime Hinton and collaborators during October of 1995 (*J. Hinton et al. 26133-26217*) and August of 1996 (*J. Hinton et al. 26641-26843*). These collectors encountered a rich herbaceous flora in moist glades of mountain saddles (*Alepidocline macdonaldana, Erigeron quiexobrensis, Hieracium abscissum, Luzula denticulata, Ottoa oenanthoides, Schiedeella hyemalis*) and an array of herbs and short-statured (≤1.0 m), lignescent phanerophytes on exposed rock and cliff faces (*Ageratina pichinchensis, Aphanactis macdonaldii, Castilleja nivibractea, Chionolaena macdonaldii, Verbesina macdonaldii, Valeriana pulchella*). Several miniature, hemi-cryptophytes and chamaephytes (*Calandrinia micrantha, Lobelia macdonaldii, Oxalis hintoniorum, Sisyrinchium tenuifolium,*

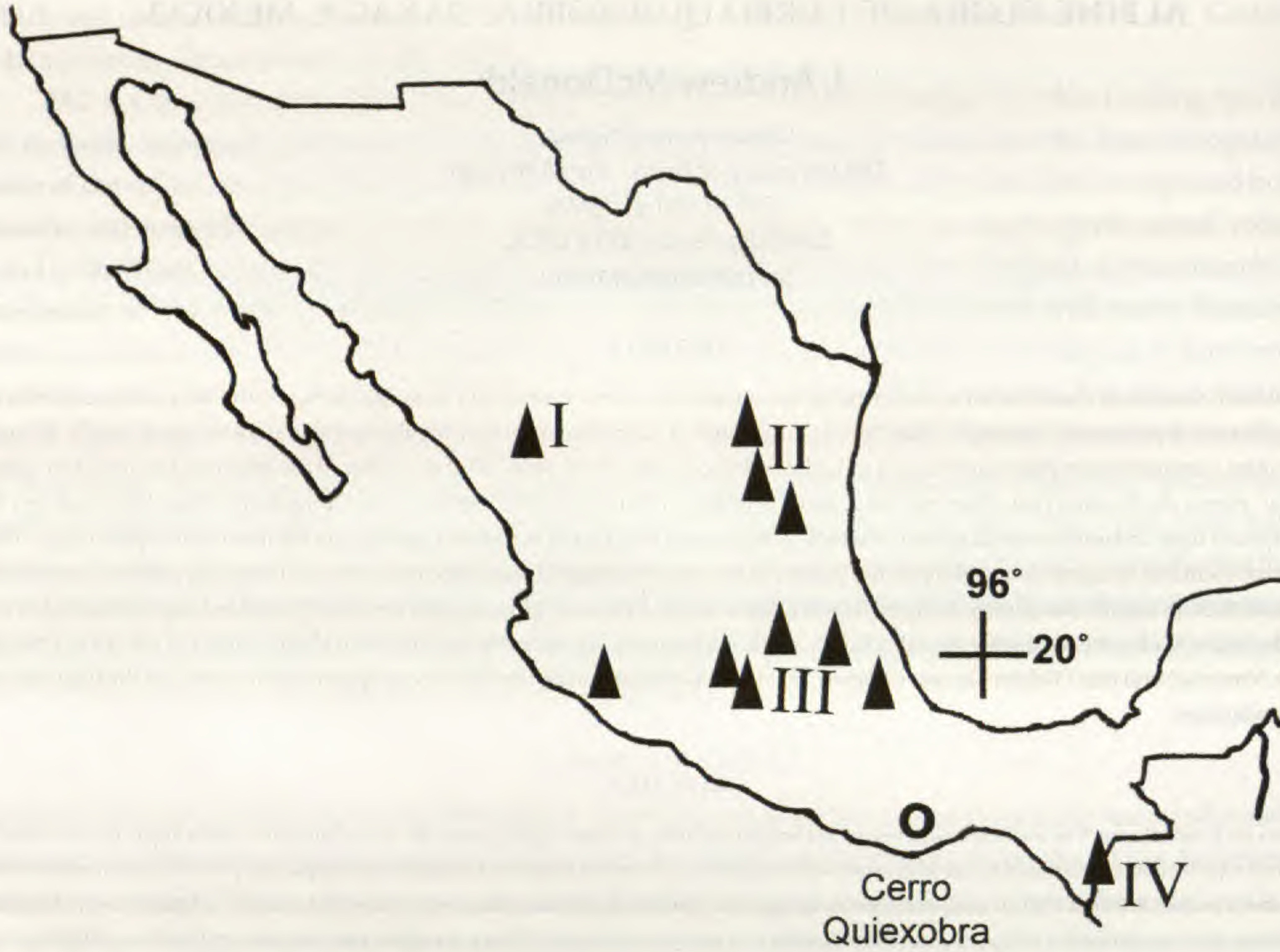

Fig. 1. Modern disjunct distribution of timberline floras in the Sierra Madre Occidental (Zone I), Sierra Madre Oriental (Zone II), central volcanic belt (Zone III), and the Volcán Tacaná (Zone IV). An isolated, relictual, and hitherto unreported alpine plant community occurs in southern Oaxaca – Cerro Quiexobra of the Sierra Madre del Sur (denoted by open circle).

Tauschia filiformis) are locally abundant and often intermingle with creeping, rhizomatous herbs, such as *Oenothera epilobiifolia*, *Potentilla macdonaldii* and a geophytic *Peperomia* (*P. monticola*). Most of the aforementioned genera occur frequently in disjunct alpine zones throughout Mexico. The timberline vegetation of Cerro Quiexobra also harbors unique and highly specialized shrubs and short trees, such as the only known arborescent bluebonnet, *Lupinus jaimehintoniana*, which occupies a shrub-dominated, subalpine ecotone between surrounding pinelands (*P.* aff. *hartwegii*) and treeless zones.

The alpine flora of Cerro Quiexobra is extraordinarily unique in various regards, owing ostensibly to its geographic isolation during the present age and glacial maxima of the Pleistocene (McDonald 1993). Comparing closely in species richness to other alpine refugia of similar size in northeast and northwest Mexico (McDonald 1990, 2011), this highly restricted plant community comprises at least 80 species of herbs and short shrubs. The vegetation is particularly noteworthy in terms of rare and endemic elements, supporting at least 19 species that are presently known exclusively from this high point of the Sierra Madre del Sur, more than double the number of single-peak endemics encountered in other alpine refugia of Mexico (Almeida-Lenero et al. 2007; Beaman 1962, 1966; Laur & Klaus 1975; McDonald 1993, 2011; Narave 1985). Unlike the closest known alpine grasslands to the north and east, Pico de Orizaba of Veracruz and Volcán Tacaná of Chiapas (respectively), as well as alpine grasslands across central Mexico's volcanic belt (19° Lat. N; Almeida-Lenero et al. 1994, 2004, 2007; Gimenez de Azcarate & Escamilla 1995; Rzedowski 1975), an array of forbs and perennial herbs of Cerro Quiexobra, mostly Asteraceae, are dominant over few grasses (5 spp.), caryophylls (2 spp.) and mustards (2 spp.). Asteraceae are especially well represented in terms of species richness (27spp.) and plant cover, and account for a substantial number of narrow endemics (11 spp.). The Apiaceae and Orobanchaceae rank second

in terms of species richness (4 spp. each), followed by the Ericaceae, Plantaginaceae, and Solanaceae, each with three species. As presently known, only two non-native species occur among the natives, *Poa annua* and *Sisymbrium* cf. *irio*, underscoring again the persistent insularity of this plant community.

The remarkable rates of narrow endemism at the summit of Cerro Quiexobra are apparently the result of long-term isolation during both glacial and interglacial periods of the Pleistocene, as well as the distinctive geological substrates of the Sierra Madre del Sur. The closest, aforementioned alpine zones to the north and east of Oaxaca occupy loose basaltic soils and gravel, while Cerro Quiexobra's flora inhabits solid, rocky substrates of a mountain range that is formed by a complex mixture of Lower Cretaceous marine sediments, Proterozoic metamorphic rock and extrusive Tertiary sedimentary volcanics (Ortega-Gutierrez 1992). With respect to evidence that timberline plant communities of Mexico descend around 1000 m during glacial maxima, the alpine vegetation of Cerro Quiexobra presumably expands in distribution during pluvials to cover around 170 km of the east-west backbone of the Sierra Madre del Sur (McDonald 1993). The geographical limits of this relatively broad distribution are still far-removed, however, from insular alpine zones to the north (Pico de Orizaba, Veracruz) by at least 200 km and to the east (Volcán Tacaná, Chiapas) by around 400 km (Fig. 1).

This epicenter of rare and potentially endangered species warrants serious attention in terms of research and protection. While timber extractions and the establishment of logging roads during the last two decades have altered surrounding pine woodlands considerably, as have widespread, recurrent and devastating fires (fide J. Hinton; Turner 1995), the short- and long-term impacts of these disturbances are essentially unknown. Given the fragility of slow-growing alpine vegetation and the significant degradation these plant communities in recent years on account of over-grazing, fires, trail erosion, and human recreation (Gimenez de Azcarate & Escamilla 1999; Almeida-Lenero et al. 2007), successful efforts to protect this biologically diverse refugium would conserve valuable evidence to better elucidate Mexico's deep and colorful, natural history.

ANNOTATED CHECKLIST OF VASCULAR PLANT TAXA

Specimens of J. Andrew McDonald (**JAM**) and Jaime Hinton (**JH**) are located at TEX, with duplicates of most of these at MEXU. Species that are known to be narrow endemics are denoted with an asterisk.

PTERIDOPHYTA

Aspleniaceae

Asplenium castaneum Schlecht. & Cham. (*JAM 3020; JH 26142*)

CONIFEROPHYTA

Pinaceae

Pinus aff. *hartwegii* Lindl. (*JAM 2945, 3031; JH 26158*)
Pinus sp. (sterile, *JAM 2945*)

MAGNOLIPHYTA

Apiaceae

Neogoezia minor Hemsl. (*JAM 2998, 3026; JH 26643*)
Ottoa oenanthoides Kunth (*JH 26217*)
Tauschia filiformis J.M. Coult. & Rose (*JAM 2999; JH 26542, 26796*)

Asteraceae

**Ageratina macdonaldii* B.L. Turner (*JAM 2916, 3006; JM 26139, 26515*)
Ageratina pichinchensis (Kunth) R.M. King & H. Rob. (*JAM 2913, 3052, 3011*)
**Alepidocline macdonaldana* B.L. Turner (JAM 3009)
**Aphanactis macdonaldii* B.L. Turner (JAM 2904, 3007; JH 26138, 26138, 26148, 26792)
**Archibaccharis macdonaldii* G.L. Nesom (JAM 2932; JH 26143)
Baccharis multiflora Kunth (*JAM 2933, 3039*)
Bidens triplinervia Kunth (*JAM 2926, 2931, 3010; JH 26155*)
**Chionolaena macdonaldii* (G.L. Nesom) G.L. Nesom (JAM 2943, 3036)
Cirsium oaxacanum G.L. Nesom (*JAM 2910; JH 26153*)
Dahlia aff. *coccinea* Cav. (*JAM 3022*)
**Erigeron quiexobrensis* G.L. Nesom (*JAM 3005; JH 26212, 26793*)
Hieracium abscissum Less. (*JAM 2912, 3034, 2912*)
**Hieracium macdonaldii* Beaman & B.L. Turner (*JAM 2950, 3037*)
Laennecia gnaphalioides (Kunth) Cass. (*JAM 2950.5*)
Osbertia stolonifera (DC.) Greene (*JAM 3008; JH 26798*)
Psacalium peltatum Cass. var. *peltatum* (*JAM 2949, 3038; JH 26156*)
**Psacaliopsis macdonaldii* (B.L. Turner) C. Jeffrey (*JAM 2992; JH 26794*)
Pseudognaphalium liebmannii (Sch.Bip. ex Klatt) Anderb. (*JAM 2934*)
Roldana hartwegii (Benth.) H. Rob. var. *subcymosa* (H. Rob.) Funston (*JH 26154*)
Roldana lineolata (DC.) H. Rob. & Brettell (*JH 26157*)
Roldana petasitis (Sims.) H. Rob. var. *oaxacana* (Hemsl.) Funston (*JAM 2951*)
Senecio callosus Sch. Bip. (*JAM 2911; JH 26211*)
**Senecio warszewiczii* A. Braun & Bouché (*JAM 2930*)
Stevia incognita Grashoff (*JAM 2946*)
Stevia lucida Lag. var. *oaxacana* (DC.) Grashoff (*JAM 2935*)
**Stevia quiexobra* B.L. Turner (3040; *JH 26141*)
**Verbesina macdonaldii* B.L. Turner (*JAM 2936*)

Boraginaceae

**Nama quiexobranum* Bacon & McDonald (*JAM 2914, 3014; JH 26147*)

Brassicaceae

Lepidium schaffneri Thell. (*JH 26788*)
Sisymbrium aff. *irio* L. (*JAM 3012*)

Campanulaceae

**Lobelia macdonaldii* B.L. Turner (*JAM 2996; JH 26146, 26151, 26786*)

Caryophyllaceae

Arenaria lanuginosa (Michx.) Rohrb. var. *lanuginosa* (*JAM 2908, JH 26215, 26802*)

Cerastium guatemalense Standl. (*JAM 2906*)

Crassulaceae

Echeveria sp. (*JAM 2944*)

Sedum mesoamericanum P. Carrillo-Reyesa & M.A. Pérez-Farrerab (*JAM 2942*);

Ericaceae

Arbutus xalapensis Kunth (*JAM 2939*)

Arctostaphylos pungens Kunth. (*JAM 2941*)

Pernettya prostrata (Cav.) DC. (*JAM 2922; JH 26149*)

Fabaceae

**Lupinus jaimehintoniana* B.L. Turner (JAM 2921; JH 26160)

Lupinus aff. *montanus* Kunth (*JAM 2923, 2921*)

Geraniaceae

Geranium seemannii Peyr. (*JAM 2907, 2990*)

Iridaceae

Sisyrinchium johnstonii Standl. (*JH 26795*)

Sisyrinchium tenuifolium Humb. & Bonp. ex Willd. (*JAM 3015; JH 26161*)

Juncaceae

Luzula denticulata Liebm. (*JAM 3027*)

Lamiaceae

Salvia stolonifera Benth. (*JAM 3004; JH 26159, 26787*)

Stachys coccinea Ortega (*JAM 2927*)

Montiaceae

Calandrinia micrantha Schltdl. (*JAM 2933*)

Claytonia perfoliata Donn ex Willd. (*JAM 2905, 2997*)

Onagraceae

Lopezia racemosa Cav. (*JAM 2918*)

Oenothera epilobiifolia Kunth (*JAM 2994; JH 26165*)

Orchidaceae

Schiedeella hyemalis (A. Rich. & Gal.) Burns-Bal. (*JAM 2915; JH 26140, 26209*)

Orobanchaceae

Castilleja integrifolia L.f. (*JAM 2937*)

**Castilleja nivibractea* G.L. Nesom (*JAM 2948, 3002*)

**Castilleja quiexobrensis* G.L. Nesom (*JAM 2928*)

**Castilleja zempoaltepetlensis* G.L. Nesom (*JH 26133, 26451, 26800*)

Oxalidaceae

**Oxalis hintoniorum* B.L. Turner, in prep (*JAM 3017; JH 26799*)

Piperaceae

Peperomia monticola Miq. (*JAM 3019*)

Plantaginaceae

Penstemon campanulatus (Cav.) Willd. (*JAM 2929*)

Penstemon gentianoides (Kunth) Poir. (*JAM 2925; JH 26134, 26801*)

Penstemon kunthii G. Don (*JAM 2929, 3025; JH 26299*)

Poaceae

Agrostis ghiesbreghtii E. Fourn. (*JAM 2938 3031*)

Koeleria pyramidata (Lam.) P. Beauv. (*JAM 2947*)

Poa annua L. (*JAM 2917*)

Trisetum cf. *pringlei* (Scribn. ex Beal) Hitch. (*JAM 2920*)

Vulpia myuros (L.) C.C. Gmel. var. *myros* (*JAM 2903, 3030*)

Ranunculaceae

Ranunculus petiolaris HBK (*JAM 2991*)

Rosaceae

Acaena elongata L. (*JAM 2940; JH 26216*)

**Potentilla macdonaldii* B.L. Turner (*JAM 2919*)

Solanaceae

Solanum demissum Lindl. (*JAM 2987*)

Solanum pseudocapsicum L. (*JH 26797, 26806*)

Solanum schenckii Bitter (*JAM 3016*)

Urticaceae

Urtica urens L. (*JAM 3003*)

Valerianaceae

Valeriana pulchella M. Martens & Galeotti (*JAM 3022*)

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BOOK REVIEW

Jane Goodall with Gail Hudson and forward by Michael Pollan. 2013. **Seeds of Hope: Wisdom and Wonder from the World of Plants.** (ISBN-13: 9781455513222, hbk). Grand Central Publishing, Hachette Book Group, 237 Park Avenue, New York, New York 10017, U.S.A. (**Orders:** www.hachettebookgroup.com/publishers/grand-central-publishing). $22.36, 384 pp., 36 color photos, many b&w photos, 6" × 9".

(continued from p. 712)

She offers wonderful cases of children—the future of environmental protection—involved in educational efforts from urban Dallas to the tip of India. She talks about grassroots movements where people rise up to protect their local resources, such as the Chipko movement in India where a group of women joined together to protect their local forests. She highlights "forest warriors" like John Seed of Australia who took on the timber industry, first in Australia and then across the globe; like Wangari Maathai, the founder of the Green Belt Movement in Kenya, who fought to halt deforestation in her native country and led the planting of "hundreds of thousands of trees around urban areas in many parts of Africa;" like Chief Almir of the Surui tribe in Brazil who stood up to illegal loggers. These "warriors" inspire and challenge us to fight for the protection of our resources. Goodall, a warrior in her own right, challenges us to never give up hope. She concludes the book with a discussion on the resilience of our natural systems, providing us with several cases of plants and systems that, even under the harshest conditions of deprivation, fight back with a strong will to survive. "Indeed," says Goodall, "nature is resilient. Therein lies our hope."

Since publication, Goodall has been accused of plagiarizing parts of the book. Having recently read the book, I can see some of the gray areas from which these accusations may come. However I question the fairness of these accusations. Here is a woman whose lengthy career has spanned decades and continents, who has been at the forefront of animal behavior research and conservation, and who has interacted with a multitude of professionals and non-professionals on a whole host of environmental subjects. In *Seeds of Hope*, Goodall weaves together a lifetime of conversations with groups and individuals. I imagine Goodall has a huge knowledgebase formed from prior conversations and collaborations, so much so, that it would be hard to unravel exact conversations in order to attribute a particular phrase or thought to a particular person when those thoughts have intermingled with one's own over decades of learning. Throughout the book she attributes ideas and research to their appropriate authors, and in fact, includes 19 pages of what she terms "Gratitude" where she thanks and gives credit to all those whose paths she has crossed in the writing of this book.

Seeds of Hope is a ramble through her long career, and I see no need in dragging an outstanding scientist through the coals for something that has likely just become a part of who she is. At nearly 80 years old, Goodall has been present for so many discussions and has taken environmental and conservation ideas to the world arena that have benefitted humankind in ways we can only begin to see.

As Michael Pollan so eloquently puts it in his forward, "*Seeds of Hope* is not just a love letter to the plant world, though it is certainly that. It's also a call to arms, sounding the alarm about habitat destruction, the violence of industrial agriculture, and the risks of genetic engineering ... Goodall wants nothing less than to expand the circle of human affection once again, making it wide enough to take in the sunlight eaters." Goodall does so with humility and grace in this reflective and thoughtful book.—*Gwen Michele Thomas, Chapter Coordinator for the Society for Ecological Restoration's Texas Chapter, Texas Master Naturalist, and Botanical Research Institute of Texas Volunteer.*

FLORA AND PHYTOGEOGRAPHY OF CUMBRES DE MONTERREY NATIONAL PARK, NUEVO LEON, MEXICO

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ABSTRACT

A study of flora of the Cumbres de Monterrey National Park (CMNP) was carried out; the area is located in the Sierra Madre Oriental physiographic province. The CMNP's flora is found in arid, temperate, and warm areas. The total flora comprises 137 families, 600 genera, and 1,300 species of vascular plants. The families with the highest number of genera and species respectively are Asteraceae (94–204), Fabaceae (50–120), Poaceae (42–93), Lamiaceae (17–52), Malvaceae (14–25), Brassicaceae (13–26), Rosaceae (12–25), Solanaceae (12–26), and Euphorbiaceae (11–43). The genera with the highest number of species are *Quercus* (24), *Euphorbia* (22), *Salvia* (18), *Ageratina* (12), *Verbesina* (11), *Senecio* (11), and *Verbena* (9). From the total species recorded, 34 (2.5%) are endemic to Nuevo Leon, with most belonging to Asteraceae (9 species) followed by the Fabacaeae (5 species). More than 90% of the CMNP flora is autochthonous. The phytogeography of CMNP corresponds mainly to three origins: warm area elements, mainly found in piedmont scrub, dominated by neotropical species; temperate area elements, distributed mainly in mixed forest (oak-pine), dominated by species from cool or cold areas; as well as endemic elements from Mexican arid lands such as Cactaceae and Agavaceae occurring mainly in xerophyllous scrublands in the Park.

Key Words: Cumbres de Monterrey National Park, Nuevo Leon, northeastern Mexico, phytogeography, flora

RESUMEN

Se estudió la flora del Parque Nacional Cumbres de Monterrey (PNCM) situado en la provincia fisiográfica de la Sierra Madre Oriental. El PNCM posee vegetación de zonas áridas, cálidas y templadas. La flora comprende un total de 137 familias, 600 géneros, 1,300 especies y 173 taxa intraespecíficos de plantas vasculares. Las familias con mayor nùemero de géneros y especies respectivamente son Asteraceae (94–204), Fabaceae (50–120), Poaceae (42–93), Lamiaceae (17–52), Malvaceae (14–25), Brassicaceae (13–26), Rosaceae (12–25), Solanaceae (12–26) y Euphorbiaceae (11–43). Los géneros con mayor número de especies *Quercus* (24), *Euphorbia* (22), *Salvia* (18), *Ageratina* (12), *Verbesina* (11), *Senecio* (11) y *Verbena* (9). Del total de especies 34 de ellas (2.5%) son endémicas de Nuevo León, la mayoría pertenecientes a Asteraceae (9 especies), Fabacaeae (5) y Pinaceae (2). Más del 90% de la flora del PNCM es autóctona. La fitogeografía del área corresponde principalmente a tres vertientes: elementos de áreas cálidos, se encuentran en matorrales submontanos con especies de orígen neotropical; elementos de áreas templadas, se localizan en bosques mixtos de pino-encino con especies de orígen netmente de áreas frías o frescas y elementos endémicos de las zonas áridas mexicanas, como el caso de las Cactaceae y Agavaceae presentes en los matorrales xerófilos del Parque.

Palabras Clave: Parque Nacional Cumbres de Monterrey, Nuevo León, noreste de México, fitogeografía, flora

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INTRODUCTION

The northeastern region of Mexico is characterized by climatic and landscape heterogeneity; its extensive plains, high mountains, and scattered hills shelter an intricate and diverse mosaic of vegetation, characterized by rich plant diversity and life forms. The heterogeneous physiography among different regions clearly differentiates distinctive climatic zones, especially evident in the State of Nuevo Leon, where three physiographic provinces are recognized: Gran Llanura de Norteamérica (North American High Plains), Llanura Costera del Golfo Norte (North Coastal Gulf Plain), and Sierra Madre Oriental (INEGI 1986). These have contrasting particularities of soils, vegetation types, and plant diversity. The orthographic, edaphic, and climatic factors of the physiographic provinces show close relationships between the vegetation types, flora, and plant endemism (Epling 1939; Woodson 1954; Barneby 1964; Johnston 1971, 1975; Powell & Turner 1974; Powell 1978; Zanoni & Adams 1979; Nesom 1981; Turner 1994a, 1994b, 1994c, 1996, 1997, 2001; Valdés & Flores 1983, 1986; Anderson 1987; McDonald 1990; Hinton & Hinton 1995; Allred & Valdés-Reyna 1997; Valdés-Reyna 1997; Espejo & López 1997; Henrickson & Johnston 1997; Valiente-Banuet et al. 1998; Estrada 1998; Valdés-Reyna & Allred 2003; Mickel & Smith 2004; Estrada et al. 2007; Balleza & Villaseñor 2011; Velazco-Macías et al. 2011; Estrada et al. 2012).

The vegetation is characterized by 11 plant communities: 1) Tamaulipan thornscrub, 2) piedmont scrub, 3) rosetophyllous scrublands, 4) microphyllous scrubland (Muller 1939; Rojas-Mendoza 1965; Rzedowski 1978; Estrada & Martínez 2003), 5) chaparral (Valiente-Banuet et al. 1998), 6) oak forest, 7) oak-pine forest (Rzedowski 1978; Perry 1991), 8) conifer forest (Miranda & Hernández 1963; Beaman & Andersen 1966; Rzedowski 1978; Perry 1991; Farjon et al. 1997; Graham 1999), 9) halophytic communities (Scott et al. 2004; Estrada et al. 2010), 10) alpine meadow (Beaman & Andersen 1966), and 11) aquatic vegetation (Rzedowski 1978).

The scrublands and forest types are present in the central part of Nuevo Leon and constitute the main landscapes of the Cumbres de Monterrey National Park (CMNP), the largest National Park in Mexico, covering an area of 177,367 ha (1773 km^2). The CMNP was established in 1939 by a presidential decree to preserve the regional flora and fauna and is one of the most visited areas in Nuevo Leon for activities such as camping, hiking, rappelling, and leisure. Small villages, ranches, private properties, and *ejidos* are widely distributed throughout CMNP; the vibrant economy is based mainly on fruits such as apples, peaches, plums, and apricots. The objective of the present work is to document the plant diversity and the phytogeography of the CMNP.

Study area

The Cumbres de Monterrey National Park is located in the central-west portion of Nuevo Leon. It includes part of seven municipalities: Allende, Montemorelos, Monterrey, Rayones, Santa Catarina, San Pedro Garza García, and Santiago (25°41'–25°02'N, 100°45'–99°11'W). The altitude ranges from 600 to 3400 m. The main urban areas in CMNP are Puerto Genovevo, El Manzano, Ciénega de González, Laguna de Sánchez, El Tejocote, El Hondable, La Camotera, La Trinidad, Potrero Redondo, El Pajonal, El Huajuco, La Huasteca, and San Antonio de la Osamenta (Fig. 1).

Geology.—The most common outcrops are from sedimentary rock and clastic deposits of the Mezozoic Era. Most outcrops in lowlands are constituted by lutites, conglomerates, and limestone. Higher in the Sierra Madre Oriental are Mesozoic limestone and recent deposits of conglomerates and alluvial soils from the Quaternary (INEGI 1986).

Soil.—Predominant soils in lowlands are regosols and lithosols, developing into rendzinas and xerosols. Intermountain valleys, as well as low plains, are mainly clay vertisols, frequently with high calcium carbonate contents and poor drainage (INEGI 1986).

Climate.—The study areas have a seasonal climatic pattern. There is a dry season from November to May and a humid season from June to October; however, some differences are evident for both the North Coastal Gulf Plain (NCGP) and the Sierra Madre Oriental (SMO) physiographic provinces (García 1973; INEGI 1986). Two main climates are dominant in the NCGP, warm and arid. The type A (C)w (semiwarm-subhumid) cli-

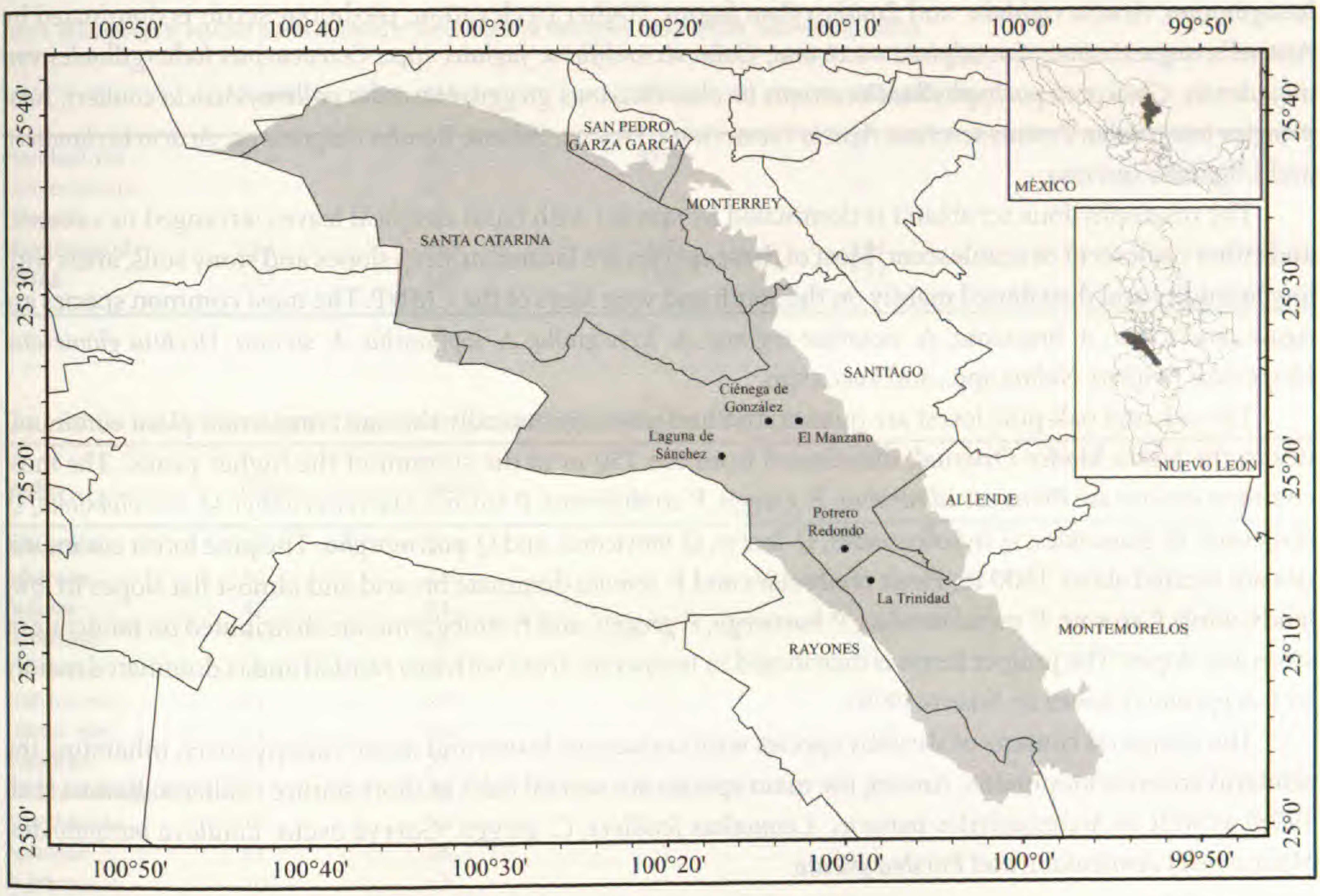

Fig. 1. Study area, municipalities, and main villages in Cumbres de Monterrey National Park, Nuevo Leon, Mexico.

mate, with 18°C as yearly mean temperature and annual rainfall averaging 1000 to 1200 mm, is distributed on the windward slopes of the CMNP. The arid-warm (BS) and arid-semiwarm(Bw) climate types are found on the leeward slopes south and west of the study area, averaging an annual mean temperature higher than 18°C and annual mean rainfall 400 mm (García 1973; INEGI 1986). Both types of climate are found at lower altitudes (400–750 m) where scrublands with different physiognomy, structure, and plant composition are the main plant vegetation. The temperate-subhumid (Cw) climate is common in the mesic and temperate areas above 750 m on windward slopes, averaging 12–18°C mean annual temperature and annual rainfall of 1500 mm. This climate is found in the mountains and slopes over 750 m, where the main plant communities are oak and conifer forest.

Vegetation.—The main vegetation types in the CMNP, according to Muller (1939), Rojas-Mendoza (1965), INEGI (1986), and Estrada et al. (2012a), are: Tamaulipan thornscrub, piedmont scrub, microphyllous scrubland, rosetophyllous scrubland, oak forest, oak-pine forest, pine forest, and *Juniperus* forest. The Tamaulipan thornscrub is a plant community dominated by medium (1–2 m) to short (1 m) shrubs, present at lowest altitudes in the CMNP.

The most common elements are: *Agave lecheguilla, Bernardia* myricifolia, *Cercidium macrum, Cordia boissieri, Eysenhardtia texana, Havardia pallens, Jatropha dioica, Karwinskia humboldtiana, Leucophyllum frutescens, Opuntia engelmannii, Schaefferia cuneifolia,* and *Acacia rigidula.*

The piedmont scrub is composed of thorny and non-thorny evergreen or deciduous shrubs, reaching up to 3 m tall, along the lower slopes of the mountains. The most common species are: *Agave lecheguilla, Amyris madrensis, A. texana, Bernardia* myricifolia, *Caesalpinia mexicana, Calia secundiflora, Celtis pallida, Cordia boissieri, Eysenhardtia texana, Forestiera angustifolia, Gochnatia hypoleuca, Havardia pallens, Helietta parvifolia, Jatropha dioica, Karwinskia humboldtiana, Leucophyllum frutescens, Malpighia glabra, Neopringlea integrifolia, Opuntia engelmannii, Randia rhagocarpa, Schaefferia cuneifolia, Acacia berlandieri, Acacia greggii, Sideroxylon*

lanuginosum, Acacia rigidula, and *Zanthoxylum fagara.* Higher in elevation, piedmont scrub is dominated by *Acaciella angustissima, Caesalpinia mexicana, Calia secundiflora, Juglans* spp., *Cercocarpus fothergilloides* var. *mojadensis, Chiococca pachyphylla, Decatropis bicolor, Fraxinus greggii, Havardia pallens, Acacia coulteri, Neopringlea integrifolia, Prunus serotina, Acacia roemeriana, Ptelea trifoliata, Randia rhagocarpa, Acacia berlandieri,* and *Ungnadia speciosa.*

The rosetophyllous scrubland is dominated by species with basal or apical leaves, arranged in a rosette, and either caulescent or acaulescent. Most of these species are located in steep slopes and stony soils, areas with low humidity and distributed mainly on the south and west faces of the CMNP. The most common species are *Agave americana, A. bracteosa, A. victoriae-reginae, A. lecheguilla, A. lophantha, A. striata, Hechtia glomerata, Hesperaloe funifera, Nolina* spp., and *Yucca* spp.

The oak and oak-pine forest are quantitative and physiognomically the most important plant communities in the Sierra Madre Oriental, distributed from the 750 m to the summit of the higher peaks. The most common species are *Pinus pseudostrobus, P. greggii, P. strobiformis, P. teocote, Quercus canbyi, Q. coccolobifolia, Q. fusiformis, Q. glaucoides, Q. hypoleucoides, Q. laceyi, Q. mexicana,* and *Q. polymorpha.* The pine forest communities are located above 1600 m; *Pinus cembroides* and *P. remota* dominate on arid and almost flat slopes in lowlands; while *P. teocote, P. pseudostrobus, P. hartwegii, P. greggii,* and *P. strobiformis* are distributed on moderate or steep wet slopes. The juniper forest is distributed in temperate areas with low rainfall and is dominated mainly by *J. deppeana* (Zanoni & Adams 1979).

The chaparral consists of shrubby species with coriaceous leaves and dense canopy cover, inhabiting the semiarid areas on mountains. Among the main species are several oaks of short stature (Valiente-Banuet et al. 1998) as well as *Arctostaphylos pungens, Ceanothus fendleri, C. greggii, Garrya ovata, Lindleya mespilioides, Malacomeles denticulata,* and *Purshia plicata.*

METHODS

Field and lab work.—Field work was carried out from 2005 to 2012, collecting plants in all plant communities present in the CMNP. Plants were identified by authors and specialists for different groups. Plants are housed in the CFNL herbarium, and duplicate sets of plants were sent to different herbaria as exchange (ANSM, BRIT, MEXU, and TEX). Previous floristic studies for Mexico, as well as monographs of most of the genera, were used to determine families and genera origin and distribution. The plant list follows Thorne's (1992 (monocots), 2000 (dicots)) classification system for Angiospermae, but for Scrophulariaceae (in part), we followed Olmstead et al. (2001) and Anthericaceae (Kim et al. 2010). We followed Crabbe et al. (1975) for ferns and allies (Pteridophyta) and Eckenwalder (2009) for Gymnospermae (conifers). The families, genera, and species of each major group are alphabetically arranged in Appendix 1.

RESULTS

Diversity

We recorded 137 families, 600 genera, 1300 species, and 173 infraspecific taxa of vascular plants in the CMNP (Table 1, Appendix 1). The families with the highest number of genera and the genera with the highest number of species are shown in Table 2 and Table 3, respectively. Twenty-four of the families (17.6%) include 65% and 66.5% of the genera and species, respectively, while the 13 most diversified genera include 12.23% of the total species. The dicotyledoneae are by far the most common plants in the CMNP, while conifers are the less diversified taxa. The Asteraceae, Poaceae, and Fabaceae families highlight as the most diversified groups of plants, and *Quercus, Euphorbia, Salvia,* and *Ageratina* stand out as the most diversified genera. These three families and four genera are distributed in all plant communities in the CMNP.

Endemism, precedence, and growth forms

From the total number of species for the CMNP, 34 of them (2.5%) are endemic (see Appendix 1 (*)) for the State of Nuevo Leon. Most of the endemic species belong to two families: Asteraceae (9 species) and Fabaceae (5). *Astragalus* is the genus with the highest number of endemic species (3). By far, the native species (1222 =

TABLE 1. Main groups of vascular plants recorded in the Cumbres de Monterrey National Park, Nuevo Leon, Mexico.

	Families	Genera	Species	Infraspecific taxa
Pteridophyta	7	20	45	7
Coniferophyta	5	8	17	8
Liliopsida	21	87	193	16
Magnoliopsida	104	485	1045	142
TOTAL	137	600	1300	173

TABLE 2. Families with the highest number of genera and species in CMNP, Nuevo Leon, Mexico.

Families	Genera	Species
Asteraceae	94	204
Fabaceae	50	120
Poaceae	42	93
Lamiaceae	17	52
Malvaceae	14	25
Brassicaceae	13	26
Solanaceae	12	26
Rosaceae	12	25
Euophorbiaceae	11	43
Acanthaceae	11	18
Apiaceae	11	16
Rubiaceae	10	17
Pteridaceae	10	23
Cactaceae	10	21
Boraginaceae	9	23
Apocynaceae	9	18
Orchidaceae	9	13
Rutaceae	9	11
Sapindaceae	8	9
Verbenaceae	7	28
Cyperaceae	7	15
Nyctaginaceae	6	14
Crassulaceae	5	11
Commelinaceae	4	8

TABLE 3. Genera with the highest number of species in the CMNP, Nuevo Leon, Mexico.

Genera	Number of species
Quercus	24
Euphorbia	22
Salvia	18
Ageratina	12
Verbesina	11
Senecio	10
Desmodium	10
Dalea	10
Verbena	9
Pinus	9
Paspalum	8
Cheilanthes	8
Asclepias	8

94%) dominate over the introduced ones (75 = 6%). Most of species recorded are herbaceous (1040; 80%) and shrubs (169; 13%), followed by trees (78; 6%), and plants with fleshy stems (26; 2%). The epiphytes, parasites, and lianas are rare.

Phytogeography

The different plant associations found in the CMNP, along with their rich plant species diversity, allow recognition of different distribution patterns of the genera throughout its altitude gradient. Table 4 shows the origin and genera number found by plant community.

The piedmont scrub (PMS) has the highest number of genera from neotropical (130) and warm origin (122). Most of its floristic components are from warmer areas origin, highlighting those shrubs and trees which are important components in this landscape. These include *Acacia, Acaciella, Buddleja, Condalia, Cordia, Diospyros, Esenbeckia, Gochnatia, Leucaena, Persea,* and *Smilax,* as well as frequently abundant herbaceous elements such as *Abutilon, Acalypha, Begonia, Commelina, Cyperus, Datura, Euphorbia, Hibiscus, Ipomoea, Jacobinia, Lantana, Mentzelia, Pavonia, Phytolacca, Ruellia, Sechium, Serjania, Sida, Tagetes, Tetramerium, Tradescantia, Tridax, Tripogandra, Turnera, Verbena, Verbesina,* and *Viguiera.* Also, the PMS has the highest typically Mexican genera such as *Ageratina, Batesimalva, Carlowrightia, Chrysactinia, Ebenopsis, Eustoma, Fleischmannia, Havardia, Hechtia, Hesperaloe, Jefea, Melampodium, Mirandea, Sanvitalia, Seymeria, Tagetes, Tigridia, Vigethia,* and *Zaluzania.* Almost half of the warm Mexican and neotropical origin genera registered in PMS are found also in the rosetophyllous scrublands (RS). Both plant communities (PMS and RS) encompass the highest number of Mexican genera, 34 and 27, respectively. Many of these genera are found in flat plains and mountains of south and west Texas (Correll & Johnston 1970).

The oak forest (OF), oak-pine forest (OPF), and pine-forest (PF), by far, cover the largest amount of temperate and North American origin genera. Most of these are from temperate and Nearctic origin, and almost always are restricted to these forests. Among the most conspicuous elements in the landscape are *Abelia, Acer, Aquilegia, Arenaria, Arracacia, Ceanothus, Cercis, Cornus, Crataegus, Geranium, Gibasis, Hexalectris, Lathyrus, Lenophyllum, Malaxis,* Monotropa, *Omphalodes, Parthenocissus, Phacelia, Physocarpus, Pinguicola, Prunus, Ranunculus, Securigera, Silene, Sisyrinchium, Stachys, Staphylea, Thalictrum, Tilia, Torilis, Toxicodendron, Triodanus, Ulmus, Urtica, Vaccinum,* and *Veronica.* The oak forest (OF) has the third highest number of Mexican genera with (23).

The juniper forest harbors the highest number of genera (77) with typically North American distribution. The most common genera are *Ascyrum, Calylophus, Cercocarpus, Conopholis, Echeandia, Fendlera, Fendlerella, Helenium, Hemichaena, Heuchera, Ipomopsis, Monarda,* Nothoscordum, *Onosmodium, Pediomelum, Phanerophlebia, Physaria,* Pyrrhopappus, *Schkhuria, Sisyrinchium,* and *Stephanomeria.* Many of them are shared with the other forest types but are rarely found in the scrublands.

DISCUSSION AND CONCLUSIONS

The Mexican Transition Zone (Darlington 1957; Halffter 2003) is a complex area where the neotropical and the Nearctic biotic elements overlap. It is an area with *in situ* evolution of many endemic taxa, and, is equivalent to the Mesoamerican Mountain Province (Cabrera & Willink 1973), to the Mesoamerican Mountain Region (Rzedowski 1978), in part to the Madrean sclerophyllous vegetation (Graham 1999), and to the Mexican Component of Mountain (Morrone & Márquez 2003). According to Rzedowski (1998), the Mexican flora has three basic geographic elements: meridional, boreal, and endemic (autochthonous). Endemism is high in plant communities in the north (arid areas) (Rzedowski 1973, 1978, 1988; Medellín-Leal 1982) as well as in southern Mexico (tropical and subtropical) (Graham 1998).

Most of the surface of the Cumbres de Monterrey National Park belongs to the Sierra Madre Oriental, located into the Mexican Transition Zone, and consists of a series of folded strata mountains, forming deep canyons crossed by narrow intermountain valleys, reaching a significant altitudinal gradient from 700 to 3400 m. This factor had favored the predominance of species of temperate affinity in the highest and rugged parts of the mountains such as *Quercus, Pinus,* and other conifers.

TABLE 4. Origin and number of genera recorded by plant community in the CMNP, Nuevo Leon, Mexico.

Plant community	Calid	Temperate	Cosmopolitan	Mexican	Neotropical	North American mainly
Piedmont scrub	122	42	26	34	130	57
Microphyllous scrubland	65	12	11	22	61	42
Rosetophyllous scrubland	61	16	13	27	64	43
Oak forest	66	102	28	23	76	64
Oak-pine forest	26	106	20	13	34	49
Pine forest	8	73	9	3	16	31
Juniper forest	15	43	10	9	20	69

In lower parts, the ravines, protected from sunlight incidence, and higher soil moisture, it is common to find plant communities typical of tropical elements (Rzedowski 1981). At lower altitudes (500 to 800 m), on the windward slopes with deep sedimentary soils (limestones and shales) of the CMNP, a continuous strip of piedmont scrub is found (Estrada et al. 2012a). This plant community is mainly composed by low, both deciduous (during the dry season) and perennial-leaved shrubs with a distinctly tropical floristic composition. The piedmont scrub has commonly dense canopy cover, and the tree-shrub strata is most frequently composed of *Acacia, Havardia, Zanthoxylum, Helietta, Cordia,* and *Diospyros.* Common associates of the piedmont scrub include afifliates of northern Mexico *Amyris madrensis, Vauquelinia corymbosa, Croton suaveolens,* and *Leucophyllum frutescens.* On the windward slopes, from 700 m and up, as well as in moist ravines, where seasonal streams drain during the rainy season, the piedmont scrub form ecotones with the oak-forest.

In some areas of the Park it is often difficult to find homogeneous oak-forest (*Quercus* spp.), since it is often mixed with other plant communities, such as the pine-forest and chaparral (dwarf oaks). These arboreal (or shrub) strata are composed mainly of Nearctic elements such as *Quercus, Arbutus, Carya, Cercis,* and *Platanus,* mixed with neotropical elements such as *Bauhinia, Croton, Litsea, Polypodium, Rhus, Ipomoea,* and *Commelina.* Furthermore, within this forest it is also common to find some genera with a preponderant xeric affinity such as *Agave, Bouteloua, Mammillaria,* and *Aphanostephus.*

In the highest parts of the mountains of the CMNP, from 1600 m up, the species of *Pinus* are dominant in the tree strata, most of them with monopodial and straight stems. The herbaceous diversity is lower here than in lower parts. In the wettest parts from the windwards in medium altitudes (1800–2000 m), the pine-forest is composed mainly of *P. teocote, P. pseudostrobus, P. montezumae, P. strobiformis,* and *P. greggii.* Occasionally this plant community constitutes ecotones with oak-forest, while in the driest areas it is common to find pure forest of *P. cembroides.* Sometimes, those constitute ecotones with xerophyllous scrublands on the leeward area adjacent to Mexican High Plateau (Altiplano Mexicano). The highest peaks, pine-forest leads to non-*Pinus* conifer forest, all of them of Nearctic affinity such as *Pseudotsuga, Abies, Juniperus,* and *Cupressus.* These forests tolerate low temperatures most of the year and occasionally snowfall. Two of these genera have patched distributions in the Park: *Taxus globosa* (a typical Nearctic element) and *Picea chihuahana* var. *martinezii* (former *Picea martinezii* (Eckenwalder 2009)), a temperate species, endemic for Nuevo Leon.

On the western part of the CMNP, on leeward slopes, the rain shadow becomes evident to the arid area; the intermountain valleys composed of alluvial sediments are surrounded by limestone steep cliffs, showing a high incidence of endemic elements characteristic of the High Plateau and the Mexican Xerophytic Region (Rzedowski 1979). The representative plant community belongs to the rosteophyllous scrubland, highlighting species from *Agave, Hechtia, Hesperaloe, Nolina,* and *Yucca.*

The CMNP has a rich plant diversity. Most of its flora is autochthonous and from warm and tropical origin, especially those that develop from the Tamaulipan thornscrub and piedmont scrub. Also, a large number of plants, mainly shrubs and trees such as *Quercus, Pinus, Juniperus, Cornus, Abies, Cercis, Platanus, Prunus, Staphylea,* and *Pseusotsuga* from temperate climates, are found and are dominant in the forest areas. This assemblage, similar in structure and composition, is also found in mid-latitude in North America and in the Mediterranean region (Graham 1999). The flora in the dry area of the CMNP shares similarities with those ele-

ments of the Chihuahuan and Sonoran Desert, such as *Larrea tridentata* (Hunizker et al. 1972), and genera such as *Caesalpinia, Celtis, Cercidium, Condalia, Cryptantha, Demanthus, Evolvulus, Flourensia, Gaillardia, Hedeoma,* Hymenoxys, *Gilia, Malvastrum, Mentzelia, Polygonum, Proboscidea, Salvia, Schkuhria, Sida,* and *Ziziphus*, among others (Raven 1963; Solbrig 1972). CMNP integrates patches of deciduous forest, very similar in plant composition to those of northeastern North America recognized by Graham (1999), and the oak-hickory (Marroquín 1968), oak-pine, and oak-hickory-*Taxodium* are the most common associations in the wettest and warmer areas (mainly in the municipality of Santiago) between piedmont scrub and oak forest. At higher elevations occur *Acer, Cercis, Cornus, Fraxinus, Juglans, Magnolia, Ostrya, Prunus, Rhus, Tilia,* and *Ulmus.* These genera and several more have been cited in previous works showing disjunctions between eastern United States and eastern Mexico (McVaugh 1943; Miranda & Sharp 1950).

All plant communities are primarily Mexican genera. However, the highest number of Mexican genera is distributed in the piedmont scrub and rosetophyllous scrubland, in the arid part of the CMNP. Most of the endemic species belong to Asteraceae and Fabaceae.

Main families and representative genera in the CMNP

The 11 most diversified families include 50% of the total flora, and can be used as a parameter to establish some comparisons of CMNP regarding the global diversity (Table 5). Eight of the flowering plant families have sub-cosmopolitan distribution (Asteraceae, Brassicaceae, Euphorbiaceae, Lamiaceae, Fabaceae, Malvaceae, Poaceae, and Solanaceae), one (Rubiaceae), tropical, and one (Fagaceae) tropical-montane-temperate (Thorne 1992, 2000). Pinaceae shows a temperate distribution (Eckenwalder 2009). Two families, (Cactaceae), with tropical temperate distribution and Pteridaceae, (mainly in tropical-subtropical areas; (Mickel & Smith 2004), are also well represented in the Park.

The Asteraceae, Fabaceae, and Poaceae are the most representative family plants in Mexico (Rzedowski 1998); the same diversification pattern occurs also in the study area. The family Asteraceae has the highest number of species (32,000) (Hendrych 1985). This family is most diverse in mountainous tropical regions, tropical areas, and in the warmer temperate regions (Turner & Nesom 1998). From the 2700 species (and 323 genera) occurring in Mexico, 96% of them (2600) are believed to be endemic (Turner & Nesom 1998). This considerable diversity is undoubtedly due to the predominance of subtropical climate, and mountains adjacent to desert regions (Turner & Nesom 1998). The study area has a similar pattern of climate (subtropical and arid) and topography (warm and cool mountains and dry plains) which undoubtedly favors such high diversity, covering 29% of the genera and 7.5% of the species occurring in Mexico. *Ageratina, Verbesina,* and *Senecio* are the most diversified genera in Mexico (Turner & Nesom 1998) and also in CMNP.

After the Asteraceae, Fabaceae is the second family of plants most diversified in Mexico (135 genera and 1724 species), growing in all ecosystems, but most numerous in tropical areas (Sousa & Delgado 1998), and 66% (121) of the genera occurring in Mexico have been recorded for the Mexican northern States (Estrada & Martínez 2003). The CMNP contains 37% and 7% of the genera and species, respectively, for Mexico. Several genera deserve mention due to their importance in the landscape. *Havardia* is a Mexican genus with nine species, six of them endemic to Mexico (Barneby & Grimes 1997); *Havardia pallens* is the only species found in the CMNP. However, it is one of the most common species in plant associations of the Tamaulipan thornscrub and piedmont scrub (Estrada et al. 2012a). *Phaseolus*, another Mexican genus, encompasses 37 species, highly diversified in Mexico (Freytag & Debouck 2002). Thirty-four of them occur in Mexico, of which 18 are endemic (Sousa & Delgado 1998). Nineteen percent of the total species of *Phaseolus* are found in the PNCM, occurring mainly in oak forest. *Dalea*, another typically Mexican genus, includes 161 species (Barneby 1977), 113 of them distributed all over Mexico. Ten of them (10%) reach the CMNP, mostly found in semiarid areas. *Desmodium* is a genus widely distributed in Mexico with almost 80 species (50 of them endemic) (Lewis et al. 2005). The study area harbors 12.5% of the total species of Mexico, and most of the 10 species found in CMNP inhabit oak-pine forest while a few of them (*D. grahamii* and *D. lindheimeri*) are distributed also in scrublands. Two highly diversified genera in Mexico, *Mimosa* (Barneby 1991) and *Acacia* (Rico-Arce 2007), are found in all plant communities in the CMNP. They are important elements because of their abundance and canopy cover, especially

TABLE 5. Plant families most diversified in CMNP compared to the diversity of the State of Nuevo Leon, Mexico, and worldwide ([1]Hendrych 1985; [2]Valdés & Cabral 1998; [3]Lewis et al. 2005; [4]Walker et al. 2004; [5]Mabberley 1997; [6]FLN 2010; [7]Fryxell 1988; [8]Rzedowski & Rzedowski 2005; [9]Martínez et al. 2011; [10]Mabberley 1997; [11]Turner & Nesom 1998; [12]Sousa & Delgado 1998; [13]Lewis et al. 2005; [14]Cornejo-Tenorio & Ibarra-Manríquez 2011; [15]Martínez-Gordillo et al. 2002; [16]Henrickson & Johnston 1997; [17]Borhidi & Diego-Pérez 2002; [18]Villarreal & Estrada 2008).

Family	Genera-species worldwide	Genera-species in Mexico	Genera-species in Nuevo Leon[18]	Genera-species in CMNP
Asteraceae	1000–32,000[1]	325–2700[11]	148–41	104–230
Poaceae	800–10,000[2]	183–1151[12]	97–301	51–134
Fabaceae	727–19,325[3]	135–1724[13]	76–258	50–120
Lamiaceae	223–5600[4]	27–512[14]	17–78	17–57
Euphorbiaceae	317–8100[5]	50–826[15]	15–85	15–51
Brassicaceae	338–3780[6]	(27[8]–42[16])–(52[8]–123[16])	30–61	15–29
Malvaceae	>100–2000[7]	55–372[7]	21–60	14–25
Rosaceae	100–3000[8]	(15[8]–17[16])–36[8,16]	20–47	13–25
Solanaceae	96–2300[9]	38–394[9]	19–70	12–28
Rubiaceae	630– 10,200[10]	85–500[17]	14–34	11–20

in areas with anthropogenic influence. However, *Mimosa* (4 species) and *Acacia* (6) are not as diversified as other genera of this family. Despite legumes being distributed all over the Park, the oak forest possesses the highest diversity, mainly in the form of herbs and shrubs, but shrubs are quantitatively most abundant in scrublands.

The Poaceae are the fourth most diversified family of plants in the world (Valdés & Cabral 1998). In Mexico it is represented by 183 genera and 1151 species (Gould 1979; Beetle 1983, 1987a, 1987b; Beetle et al. 1991, 1995, 1999; Valdés & Cabral 1998). According to Cross (1980), the Poaceae are abundant in "open communities." This could be the reason that this family, while being the third most diversified in CMNP (42 genera, 93 species), does not constitute a physiognomically important part of the landscape, except for some weeds such as *Cynodon dactlyon*, *Cenchrus ciliaris*, *Rhynchelytrum repens*, and *Eleusine indica*, all occasionally found in fragmented patches with anthropogenic disturbance. *Paspalum*, a New World genus (Renvoize 1995; Sánchez-Ken 2010), with almost 87 species in México (Guzmán & Santana 1987), 20 of which are endemic, is one of the most diversified genera in PNCM (8 species), inhabiting almost all plant communities.

Lamiaceae is the fourth most diversified family in CMNP. Four of its genera have five or more species (*Stachys*, *Hedeoma*, *Scutellaria*, and *Salvia*). By far, *Salvia* dominates over the other genera: it represents almost 1,000 species around the world (Walker & Elisen 2001). Mexico is considered one of the areas with the highest diversity of the genus in the world (Ramamoorthy 1984; Walker et al. 2004) with almost 300 species. It is considered the second most diversified in Mexico (Cornejo-Tenorio & Ibarra-Manríquez 2011). Approximately 6% of the species in Mexico are in the study area. Two of the endemic species recorded for the State of Nuevo Leon are distributed in the CMNP: *Scutellaria monterreyana* and *Stachys vulnerabilis* (Villarreal & Estrada 2008). Three of the most common cultivated mints—*Mentha pipertia*, *M. spicta*, and *M. rotundifolia*—are introduced in America (Bailey 1951) and are used as ornamental and medicinal plants (Estrada et al. 2012b). They are commonly found in CMNP (Villarreal & Estrada 2008).

Malvaceae (with more than 100 genera and 2000 species) is mainly American and probably from South America in origin. However, Mexico appears to represent a region of diversification of this family (Fryxell 1988); the family is most richly developed in the lower elevations along both coasts (Pacific and Gulf). CMNP includes 25% of the genera and 6.7% of the species of Malvaceae occurring in Mexico, most of them developing in the lower parts of the Park and commonly found in disturbed areas. The largest genera found in Mexico (as well as worldwide) are *Abutilon*, *Hibiscus*, *Sida*, and *Pavonia* (Fryxell 1988). Several species of them reach CMNP, especially those of *Hibiscus* (11% of the Mexican species) and *Sida* (11.5% of the Mexican species). Also, several species of genera "almost endemic" to Mexico (Fryxell 1988), such as *Anoda*, *Allowissadula*, and *Meximalva*, are distributed in CMNP.

The subcosmopolitan Brassicaceae includes species especially distributed in temperate areas (Flora of North America 2010). Most of them are distributed in the Northern Hemisphere (Rzedowski & Rzedowski 2005), with 616 of them occurring in the USA (Flora of North America 2010). There is not an exhaustive study of this family for Mexico. However, 27 genera and 52 species have been recorded for the Valle of Mexico (Rzedowski & Rzedowski 2005), and 30 and 123, respectively, for the Chihuahuan Desert Region (Henrickson & Johnston 1997). Half of those same genera and almost half of those species are also found in CMNP. Some genera such as *Lepidium*, *Eruca*, and *Sisymbrium* constitute an important part of the weeds found in abundance at low disturbed areas, while others such as *Cardamine*, *Diplotaxis*, *Lunaria*, *Physaria*, and *Thelypodium* are found most of the time in restricted higher altitudes in forest vegetation. *Rorippa nasturtium-aquaticum* grows abundantly on the banks of rivers and streams after rainy seasons.

The Rosaceae from CMNP includes mainly subshrubs, shrubs, and trees. Most of the genera recorded are almost the same (except for *Petrophytum* and *Agrimonia*) as those recorded for the Chihuahuan Desert region (CDR) (Henrickson & Johnston 1997). Most of the species inhabit cool areas, especially the wild ones. From the 36 species recorded for the CDR and Mexican Valley (Rzedowski & Rzedowski 2005), 70% of them are distributed in CMNP. *Crataegus*, *Rubus*, and *Rosa* are the most diversified genera.

Mexico is a center of diversity for Solanaceae (Cuevas-Arias et al. 2008). Most of its species are distributed in warm and temperate areas (Rzedowski & Rzedowski 2005). CMNP contains 31.5% of the genera and 6.5% of the species occurring in Mexico. Most of the species (64%) belong to four genera: *Capsicum*, *Nicotiana*, *Physalis*, and *Solanum*.

Rubiaceae is the fourth most diversified family in the world (Mabberley 1997), distributed mainly in tropical areas. This family is well represented in Mexico (Borhidi & Diego-Pérez 2002), and most of the species are distributed in the south region (Rzedowski 1978). In the study area 11.7% and 3.5% of the genera and species occur, respectively. The most diversified genera are *Galium* and *Hedyotis*, representing small herbaceous species, found in almost all plant communities. *Randia* is an important element of the piedmont scrub, sometimes as co-dominant species of this vegetation (Estrada et al. 2012a).

Mexico has one of the most highly diversified pteridophyte flora (ferns) in the world, inhabiting a broad range of habitats, consisting of 1,008 species and 124 genera (Mickel & Smith 2004). The CMNP includes 15% of the genera and 4% of the species for Mexico; most of the species inhabit shaded or partially shaded areas in oak and oak-pine forest. Among the most diversified genera in Mexico are *Asplenium* (86 species), *Selaginella* (30 species), *Thelypteris* (69), *Cheilanthes* (60), *Polypodium* (55), *Nothoalena* (24), and *Adiantum* (35) (Mickel & Smith 2004). Several species of these genera reach CMNP, but only one, *Chelianthes chipinquensis*, is endemic for this area.

Euphorbiaceae is one of the most diverse families in the Angiosperms (Radcliffe-Smith 1987); 50 genera and 826 species have been recorded for Mexico (Martínez-Gordillo et al. 2002). This family is the ninth most diverse in CMNP; three of its genera, *Euphorbia*, *Croton*, and Acalypha, have most of the species (72%). CMNP possesses 9.1% of the *Euphorbia* (sensu lato) species occurring in Mexico (241).

The Cactaceae are native from America (Hunt 1999); this family is characteristic of the landscape in arid lands of Mexico (Bravo-Hollis 1978; Bravo-Hollis & Sánchez Mejorada 1991a, 1991b). Mexico has the richest diversity of Cactaceae (Guzmán et al. 2003). Surprisingly, CMNP is not as diverse in Cactaceae as other representative families. Even though there are arid areas on the western and the most northern portion of CMNP, this low diversity could be caused by the relative homogeneity of the landscape and altitude gradient where the microphyllous (in plains) and rosetophyllous scrublands (hills and piedmont) occur; both of them are quite homogeneous. CMNP contains 12% of the genera and 3.7% of the species registered for Mexico. Three typically Mexican genera of this family are the most diversified in CMNP: *Echinocereus*, *Mammillaria*, and *Opuntia*. One of the endemic cacti (*Echinocereus viereckii* ssp. *morricalii*) recorded for Nuevo Leon is found in the study area.

Much like the Cactaceae, the Agavaceae are not very diverse in the CMNP; they represent only 3.8% of the 261 species occurring in Mexico. However, 50% of its genera are present in CMNP. Within Agavaceae, *Agave* is the genus most diversified: 136 (Gentry 1998)–159 (García-Mendoza 2011) species, with almost 77% of these

endemic to Mexico (García-Mendoza 2011). *Agave albopilosa* is the only species of Agavaceae endemic to CMNP, restricted to tall cliffs, in lithosols.

Among the woody plants, *Quercus* is one of the most important, and the mountains of Mexico are the center of diversity for the Western Hemisphere (Nixon 1998). The oak forest contains the main component in terms of biomass, particularly in the oak-pine forest, chaparral (oak scrubland), and in the rain forest (Rzedowski 1978). The woody species exhibit several growth forms: rhizomatous shrubs, low trees, and tall trees. It is estimated almost 200–225 species of oak exist for the west hemisphere; from those, 130–135 species are distributed in Mexico, and 57 of them reach the eastern portion of Mexico (Nixon 1998). Oaks in eastern Mexico are distributed mainly in the highlands of the Sierra Madre Oriental in the State of Nuevo Leon (Nixon 1998). Almost half of these species (24, 42%) are found in the CMNP and, by far, are the most important in terms of canopy cover and density. The most common species of the CMNP are *Q. emoryi* and *Q. polymorpha*, associated with conifer forest and piedmont scrub, constituting ecotones among shrublands and forest.

Economically and ecologically *Pinus* and *Quercus*, are two of the most important genera in Mexico, distributed in all areas where mountains are present. The genus *Pinus* is represented by 90–210 species (Silba 1984; Styles 1998) of which 49 (45.5%) of them are found in Mexico (Styles 1998). The genus inhabits mainly temperate areas. The highest diversity centers, however, are located south of the Tropic of Cancer in the south of Mexico, Central America, and the Caribbean Islands (Styles 1998). According to Eckenwalder (2009), in the State of Nuevo Leon there are 10 genera and 34 species of conifers (Villarreal & Estrada 2008); of those, 15 species and 7 infraspecific categories belong to *Pinus*. Eight genera and 15 of these conifer species are found in CMNP, and, by far, *Pinus* is the most diversified genus (9 species). Its species are widely distributed above 850 m throughout the area of the Park. The most common is *P. pseudostrobus* in wet and temperate areas, while *P. cembroides* is the most common in the arid-temperate ones. *Pinus remota*, one of the pinyon group, occupies the dry-temperate valleys in the western portion of the Park. *Picea mexicana* var. *martinezi*, *Taxus globosa*, *Cupressus arizonica* var. *arizonica*, and *Pseudotsuga menziesii* have more restricted distributions. *Picea* and *Taxus* occur mainly in protected wet places; *Taxus* grows better along creeks with rocky soils (García-Aranda et al. 2012), while *Picea* has even more restricted distribution in the Park, growing only in one place (El Butano, 1300 m). The latter is an amazing area where *Abies*, *Juniperus*, *Picea*, *Pinus*, *Pseudotsuga*, and *Taxus* share a small (2–3 ha) bowl-shaped area, protected by 150–200 m tall cliffs where dense fogs form; that constitutes a unique microhabitat capable of sheltering such a high diversity of conifer genera.

The CMNP holds almost a third of the flora known to occur in the State of Nuevo Leon. Most of its flora is autochthonous. The dominant plant communities are scrublands and oak-pine forest. The highest diversity of species was recorded in the oak forest and piedmont scrub. Most of the flora recorded is from subtropical affinity. However, the highest parts accommodate many genera from temperate and cool regions. Two families, Cactaceae and Agavaceae, dominate in the arid environments of the Park but are scarcely represented in the forest and piedmont scrub. The most diversified plant families around the world, as in genera and as in species, are also dominant in the CMNP.

Weeds and useful plants

A number of herbaceous weed species are present in the CMNP. They are dominant elements in the farms and halted crops fields and are evident in plains and valleys. One of the most common is *Rumex mexicanus*, which invades extensive areas after rains. Farmers and ranchers in the area mentioned the plant is used to feed cattle. Among the most conspicuous species introduced from Africa (Rzedowski & Rzedowski 1990) and present in the study area are *Cenchrus ciliaris*, *Cynodon dacytlon*, *Eleusine indica*, *Leonotis nepetifolia*, *Rhynchelytrum repens*, *Ricinus communis*, and *Sorghum halepense*, found in small patches. Almost 240 species, 170 genera, and 69 families of plants that grow in the CMNP are commonly used in the local subsistence culture, most as medicinal products while others are used for human consumption, fodder for livestock, firewood, construction materials, live fences, etc. (Estrada et al. 2007). *Vicia villosa* is used for fodder in U.S.A. (Gunn 1979) and also grows in open fields together with *Rumex mexicanus*. Local residents said this species is preferred by cattle over other weeds.

APPENDIX 1

List of taxa recorded at the Cumbres de Monterrey National Park, Nuevo Leon, Mexico, and endemic species (*) for Nuevo León occurring in the CMNP. E.E. = Eduardo Estrada.

PTERIDOPHYTA

Anemiaceae

Anemia adiantifolia (L.) Sw., E.E. 16371, 16379.

Aspleniaceae

Asplenium resiliens Kunze, E.E. 16292, 16354, 16445; TEX 237621, 237625.

Phanerophlebia auriculata Underw., E.E. 16510.

Phanerophlebia umbonata Underw., E.E. 11303, 16143, 16517.

Scolopendrium scolopendrium H. Karst., E.E. 16338.

Equisetaceae

Equisetum hyemale L. var. *affine* (Engelm.) A.A. Eaton, E.E. 16569; TEX 267678.

Equisetum laevigatum A. Braun, E.E. 16079, 16474, 18898.

Polypodiaceae

Phlebodium aureum (L.) J. Sm., E.E. 11303a.

Pleopeltis guttata (Maxon) E.B. Andrews & Win, J.V. 8563, TEX 214760.

Pleopeltis polylepis T. Moore var. *erythrolepis* (Weath.) T. Wendt, E.E. 16518.

Pleopeltis polylepis T. Moore var. *polylepis*, TEX 255035.

Pleopeltis polypodioides (L.) E.G. Andrews & Windham var. *michauxiana* (Weath.) E.G. Andrews & Windham, LL 232208, 232212; TEX 232209, 232210.

Polypodium plesiosorum Kunze, LL 232130; TEX 232128, 232131, 232132, 255032.

Polypodium subpetiolatum Hook., TEX 232280.

Pteridaceae

Adianthum capillus-veneris L., E.E. 14648, 16520, 16565; LL 236380; TEX 236381, 236382, 236388, 236390, 236565.

Argyrochosma microphylla (Mett. ex Kuhn) Windham, E.E. 19529.

Aspidotis meifolia (D.C. Eaton) Pic. Serm., LL 269149.

Astrolepis integerrima (Hook.) D.M. Benham & Windham, TEX 268302, 268323.

Astrolepis sinuata (Lag. ex Sw.) D.M. Benham & Windham, E.E. 16263.

Cheilanthes aemula Maxon, LL 268448.

Cheilanthes alabamensis (Buckley) Kunze, E.E. 11317, 11319; LL 268437; TEX 268466, 268470, 268471.

Cheilanthes bonariensis (Willd.) Proctor, E.E. 16270; LL 268692.

**Cheilanthes chipinquensis* Knobloch et Lellinger; BEP. (Mickel & Smith 2004).

Cheilanthes eatonii Baker, E.E. 16493; TEX 268766.

Cheilanthes horridula Maxon, TEX 268958.

Cheilanthes microphylla (Sw.) Sw., E.E. 15999, 16135, 16227, 16257, 16269, 16290, 16453, 16637, 16734, 19286, 19338, 19518; TEX 269184, 269185, 269186, 269187.

Cheilanthes tomentosa Link, TEX 237221, 269312.

Mildella fallax (M. Martens & Galeotti) G.L.Nesom, LL 269410.

Mildella intramarginalis (Kaulf ex Link) Trevis. var. *intramarginalis*, E.E. 16293.

Notholaena aschenborniana Klotzsch, E.E. 16258.; TEX 269455, 269456.

Notholaena candida (Mart. & Galeotti) Hook. var. *copelandii* (C.C. Hall) Tryon, E.E. 11293.

Pellaea atropurpurea (L.) Link, E.E. 16000, 16278, 16638; LL 269927.

Pellaea ovata (Desv.) Weath., E.E. 16202.

Pteris cretica L., E.E. 16505, 16511, 16543; LL 268061, 268062; TEX 268079, 268089, 268093.

Pteris longifolia L., E.E. 14646, 16181, 16563, 19093; G.H. 24120, 24417.

Pteris vittata L., TEX 268116, 268124, 268163.

Schizaceae

Llavea cordifolia Lag., E.E. 11295, 16127, 16556; LL 236065, 236066, 236090; TEX 236047, 236048, 236050, 236051, 236067, 236097.

Selaginellaceae

Selaginella delicatissima Linden ex A. Braun., TEX 267369.

Selaginella lepidophylla (Hook. & Grev.) Spring, TEX 267407, 267425.

Selaginella novoleonensis Hieron, G.H. 24122.

Selaginella pallescens (C. Presl.) Spring, E.E. 15997; TEX 267501.

Selaginella pilifera A.Braun, E.E. 16273; TEX 267562, 267564, 267565, 267567, 267568.

Selaginella wrightii Hieron, TEX 267660, 267664.

Thelypteridaceae

Thelypteris concinna (Willd.) Ching, E.E. 16641.

Thelypteris ovata R.P. St. John var. *lindheimeri* (C. Chr.) A.R. Sm., E.E. 11313.

Thelypteris rudis (Kuntze) Proctor, E.E. 16514, 16573.

GYMNOSPERMAE

Cupressaceae

Cupressus arizonica Greene, E.E. 11809, 19561; G.H. 24371; TEX 144937.

Juniperus deppeana Steud., E.E. 11282.

Juniperus flaccida Schltdl., E.E. 12741, 16020; G.H. 25910, LL 145516; TEX 145514.

Ephedraceae

Ephedra antisyphilitica Berland. ex C.A. Mey, E.E. 14538.

Pinaceae

Abies vejari Martinez, E.E. 11810, 15466.

**Picea chihuahuana* M. Martínez var. *martinezii* (T.F. Patt.) Eckenwalder, E.E. 11805, 15465; TEX 370052.

Pinus cembroides Zucc., E.E. 19558, 19568.

**Pinus culminicola* Andresen & Beaman var. *johannis* (Rob.-Pass.) Silba, LL 144362.

Pinus remota (Little) L.H. Bailey & Hawksw., E.E. 15199.

Pinus greggii Engelm. ex Parl., E.E. 12731, 15987.

Pinus hartwegii Lindl., TEX 144335.

Pinus lumholtzii B.L. Rob. & Fernald, E.E. 11813 (cultivado).

Pinus montezumae Lamb., LL 144461.

Pinus pinceana G. Gordon (Favela et al. 2009).

Pinus pseudostrobus Lindl. var. *pseudostrobus* Lindl., E.E. 11281, 11814, 15436, 16425; G.H. 24457, 24958, 24959; LL 144627; TEX 144609, 144618, 144620, 144625.

Pinus teocote Schltdl. & Cham., E.E. 11803, 11812, 14662, 15448, 15988, 16478a, 19123, 19156, 19174, 19384; TEX 144723, 144726.

Pseudotsuga menziesii (Mirbel) Franco, J.V. 7116.

Taxaceae

Taxus globosa Schltdl., E.E. 11804, 15467, 15993, 16129, 16299, 16373, 16383, 16507, 16545, 19155, 19436.

Taxodiaceae

Taxodium mucronatum Ten., G.H. 24168; LL 144900, TEX 144903.

MONOCOTYLEDONEAE

Agavaceae

Agave albopilosa Cabral, Villarreal & E. Estrada, E.E. 20719.
Agave bracteosa S. Watson ex Engelm., E.E. 12749; TEX 113659.
Agave lecheguilla Torr., E.E. 16204, 19637.
Agave striata Zucc., E.E. 16208, 16652.
Agave victoriae-reginae T. Moore, E.E. 12748; TEX 113815, 113857, 183034.
Hesperaloe funifera (K. Koch) Trel. ssp. *funifera*, E.E. 19638; E.E. 19475.
Manfreda maculosa Rose, E.E. 16130, 16321, 16372.
Manfreda variegata (Jacobi) Rose, G.H. 24407; TEX 111430.
Yucca filifera Chabaud, E.E. 16232, 19543, 19636, 19638, 19639.

Alliaceae

Allium glandulosum Link & Otto., E.E. 16635, 16455; J.V. 8662.
Allium hintoniorum B.L. Turner, LL 112240; TEX 112239.
Allium sativum L., E.E. 16370.
Nothoscordum bivalve (L.) Britton, LL 177743; TEX 177766.

Amaryllidaceae

Cooperia pedunculata Herb., G.H. 24413.

Anthericaceae

Echeandia chandleri (Greenm. & C.H. Thomps.) Cruden, E.E. 18917.
Echeandia flavescens (Schult. & Schult. F.) Cruden, E.E. 16632.

Araceae

Arisaema dracontium (L.) Schott & Endl., E.E. 16658; LL 176330.
Xanthosoma sagittifolium (L.) Schott & Endl. TEX 214787.

Asphodelaceae

Asphodelus fistulosus L., E.E. 14637, 16025, 19266.

Bromeliaceae

Hechtia texensis S. Watson, E.E. 19635.
Tillandsia bartramii Elliot, LL 176680; TEX 176684.
Tillandsia parryi Baker, LL 183060.
Tillandsia recurvata Gaudich., E.E. 19316.
Tillandsia usneoides (L.) L., E.E. 19335, 19367.

Cannaceae

Canna indica L., E.E. 16557, 16600.

Commelinaceae

Commelina dianthifolia Delile, E.E. 14839.
Commelina diffusa Willd. ex Kunth, TEX 110235.
Commelina erecta L. var. *angustifolia* (Michx.) Fernald, E.E. 16243; G.H. 24237, 24330; TEX 110388.
Gibasis karwinskyana (Roem. & Schult.) Rohweder ssp. *palmeri* D.R. Hunt, G.H. 24401.
Gibasis pellucida (Marttens & Galeotti) D.R. Hunt, E.E. 14653; G.H. 24100; TEX 110655.
Tradescantia crassifolia Cav., E.E. 18963.
Tradescantia pringlei S. Watson, E.E. 13336, 16781; J.V. 7099, 8684.
Tripogandra angustifloia (B.L. Rob.) Woodson, E.E. 19072.

Cyperaceae

Bulbostylis juncoides (Vahl) Kük. ex Osten, LL 174098.
Carex leucodonta T. Holm, E.E. 16309.
Carex planostachys Kunze, E.E. 16329.
Cyperus hermaphroditus (Jacq.) Standl., TEX 174419.
Cyperus niger Ruiz & Pav., TEX 174658, 174668.
Cyperus ochraceus Vahl, E.E. 16193, 16225, TEX 174695.
Cyperus odoratus L., TEX 245898.
Cyperus pallidicolor (Kük.) G.C. Tuker, E.E. 16472, 16488, 16506; LL 174738.
Cyperus retroflexus Buckley, E.E. 16655, 16739, 18945.
Cyperus rotundus L., TEX 245898.
Eleocharis geniculata (L.) Roem. & Schult., TEX 175098, 175101.
Eleocharis montevidensis Kunth, TEX 245724.
Fuirena simplex Vahl, E.E. 16566, TEX 175629, 175630.
Rhynchospora colorata (L.) H. Pfeiff., E.E. 16578; TEX 175705.
Scleria oligantha Michx., LL 175969.

Hydrocharitaceae

Najas guadalupensis (Spreng.) Morong, TEX 142268, 142269, 142274.

Hypoxidaceae

Hypoxis mexicana Schult., E.E. 16627.
Hypoxis pulchella G.L. Nesom, LL 113570; TEX 113568, 370288.

Iridaceae

Eustylis purpurea (Herb.) Engelm. & A. Gray, E.E. 16320.
Sisyrinchium demissum Greene, E.E. 16053.
Sisyrinchium dimorphum R.L. Oliv., G.H. 24133.
Sisyrinchium novoleonense G.L.Nesom & L. Hernández., TEX 278187.
Sisyrinchium scabrum Cham. & Schltdl., E.E. 15990, 16051; TEX 278346.
Sisyrinchium schaffneri S. Watson, J.V. 7137.
Tigridia pavonia (L.) DC., TEX 278848.

Juncaceae

Juncus nodosus L., TEX 177027.

Melanthiaceae

Schoenocaulon macrocarpum Brink., J.V. 8676.
Schoenocaulon texanum Scheele, E.E. 16339, 16386.
Zigadenus virescens (Kunth) J.F. Macbr, LL 177187; TEX 177190.

Nolinaceae

Dasylirion berlandieri S. Watson, G.H. 24421; TEX 111114, 111128.
Dasylirion texanum Scheele, E.E. 16180.
Nolina caespitifera Trel., E.E. 19519.

Orchidaceae

Corallorhiza bulbosa A. Rich. & Galeotti, E.E. 19612.
Corallorhiza maculata Greene, E.E. 16262.
Corallorhiza wisteriana Conrad, TEX 190364.
Dichromanthus cinnabarinus (La Llave & Lex.) Garay, TEX 190377.
Goodyera oblongifolia Raf., LL 190387; TEX 190385.
Govenia liliacea Lindl., G.H. 25470.
Hexalectris grandiflora (A. Rich. & Galeotti) L.O. Williams, G.H. 25453.
Malaxis hintonii Todzia, TEX 190414, 190416.
Malaxis wendtii Salazar, G.H. 25934.
Platanthera brevifolia (Green) Kraenzl., TEX 190451.
Platanthera limosa Lindl., E.E. 16342.
Prescottia tubulosa (Lindl.) L.O.Williams, TEX 190469.
Schiedeella rubrocalosa (B.L. Rob. & Greenm.) Burns-Bal., TEX 190492.

Poaceae

Andropogon glomeratus (Walter) Britton Sterns & Poggneb., TEX 142604.
Aristida glauca (Nees.) Walp., TEX 142902.
Aristida purpurea Nutt. var. *nealleyi* (Vasey) Allred, TEX 143037.
Aristida purpurea Nutt. var. *purpurea*, E.E. 14700, 16662, 16688, 19492.
Arundinella berteroniana (Schult.) Hitchc. & Chase, E.E. 16571, 19697; TEX 143340, 143344.
Avena fatua L. var. *fatua*, E.E. 16096.
Avena fatua L. var. *sativa* (L.) Husskn., TEX 143396.
Bothriochloa ischaemum (L.) Keng var. *songarica* (Rupr. ex Fisch & C.A. Mey.) Celarier & J.R. Harlan, E.E. 19687.
Bothriochloa laguroides (DC.) Herter var. *torreyana* (Steud.) M. Marchi & Longi-Wagner, E.E. 16740.
Bothriochloa saccharoides (Sw.) Rydb., E.E. 11318; LL 143589; TEX 142656, 143601, 143608.

Bothriochloa saccharoides Rydb. var. *torreyana* (Steud.) Gould, E.E. 16740.

Bouteloua barbata Lag., TEX 143717, 143730.

Bouteloua curtipendula (Michx.) Torr., E.E. 11309, 16395, 16783, 19175, 19217; LL 143926.

Bouteloua curtipendula (Michx.) Torr., var. *caespitosa* Gould & Kapadia, TEX 143834.

Bouteloua repens (Kunth) Scribn., E.E. 16245, 16670; TEX 246399.

Bouteloua trifida (Thurb.) ex S. Watson, E.E. 16723.

Brachypodium mexicanum (Roem & Schult) Link, E.E. 16315.

Briza minor L., E.E. 13313, 16450.

Briza subaristata Lam., E.E. 15453, 19588; TEX 246759.

Bromus anomalus Rupr. ex E. Fourn., TEX 246788.

Bromus carinatus Hook. & Arn., E.E. 16391; 16469.

Bromus catharticus Vahl, E.E. 14664, 15976, 16026.

Bromus meyeri Swallen, E.E. 12730; TEX 246944, 246946.

Buchloe dactyloides (Nutt.) Engelm., E.E. 16414.

Cenchrus incertus M.A. Curtis, E.E. 16679.

Chasmanthium latifolium (Michx.) H.O. Yates, TEX 245268.

Chloris andropogonoides E. Fourn., TEX 245273.

Chloris submutica Kunth, E.E. 16440.

Cynodon dactylon (L.) Pers., E.E. 16189, 16853, 18968, 19209, 19243, 19675.

Dasyochloa pulchella (Kunth) Willd. ex. Rydb., E.E. 16690, 16716.

Dichanthelium acuminatum (Sw.) Gould & C.A. Clark, E.E. 16349, 16570, 19696; TEX 186235.

Dichanthelium pedicellatum (Vasey) Gould, TEX 186275, 186276, 186277.

Dichanthelium sphaerocarpon (Elliott) Gould, LL 186284.

Digitaria bicornis (Lam.) Roem. & Schult., E.E. 16663, 19691.

Digitaria californica (Benth.) Henrard, E.E. 19706.

Digitaria ciliaris (Retz.) Koeler, E.E. 16205, 16685, 16725, 16772, 18975; TEX 186352.

Digitaria cognata (Schult.) Pilg. ssp. *pubiflora* (Vasey) Wipff, TEX 186369.

Digitaria hitchcockii (Chase) Stuck., E.E. 16726.

Digitaria insularis (L.) Fedde, TEX 158502.

Digitaria sanguinalis (L.) Scop., E.E. 16838; TEX 186403.

Eleusine indica (L.) Gaertn., E.E. 16194, 16779, 19069.

Elymus canadensis L., E.E. 16119, 16390, 16458, 19005.

Elymus longifolius (J.G. Smith) Gould, E.E. 14868.,

Elymus pringlei Scribn. & Merr., TEX 186720, 186721.

Enneapogon desvauxii P. Beauv., TEX 186795.

Eragrostis barrelieri Daveau, E.E. 16623.

Eragrostis intermedia Hitchc. var. *oreophila* (L.H. Harv.) Witherspoon, TEX 188006.

Eragrostis lugens Nees., LL 188025; TEX 188023.

Eragrostis mexicana (Hornem.) Link ssp. *mexicana*, E.E. 16285; G.H. 24972.

Eragrostis pilosa (L.) P. Beauv., E.E. 16544, 16682.

Erioneuron pilosum (Buckley) Nash, E.E. 19495; TEX 188476, 188492.

Festuca amplissima Rupr., E.E. 19149; TEX 80617.

Glyceria striata (Lam.) Hitchc., TEX 255157.

Hyparrhenia hirta (L.) Stapf, TEX 80877, 80882.

Koeleria pyramidata (Lam.) P. Beauv., LL 81001.

Leersia monandra Sw., TEX 81256.

Leptoloma cognata (Schult.) Chase, E.E. 16683, 16719.

Lycurus phleoides Kunth, E.E. 16397.

Muhlenbergia dubia Hemsl., E.E. 14707; TEX 81780.

Muhlenbergia emersleyi Vasey, E.E. 16410.

Muhlenbergia utilis (Torr.) Hitchc., TEX 82594.

Nassella leucotricha (Trin. & Rupr.) Barkwort, E.E. 16052, 16174, 16335; J.V. 8597.

Nassella mucronata (Kunth) R.W. Pohl, E.E. 16378.

Oplismenus hirtellus (L.) P. Beauv., E.E. 18931, 19344; J.V. 8702.

Panicum antidotale Retz, E.E. 19712.

Panicum bulbosum Kunth, J.V. 8595; TEX 83051.

Pappophorum bicolor E.Fourn., TEX 83527.

Paspalum botteri (E. Fourn.) Chase, TEX 83599.

Paspalum conjugatum P.J. Bergius, TEX 83626.

Paspalum dilatatum Poir., E.E. 14656, 14673.

Paspalum distichum L., TEX 83688.

Paspalum hartwegianum E. Fourn., TEX 83697.

Paspalum langei (E. Fourn.) Nash, TEX 83746, 83749, 83758, 83770.

Paspalum pubiflorum E. Fourn., E.E. 16169, 18977; TEX 83895, 83900.

Paspalum unispicatum (Scribn. & Merr.) Nash, TEX 83954.

Piptochaetium angustifolium (Hitchc.) Valencia &Costas, TEX 75272.

Piptochaetium fimbriatum (Kunth) Hitchc., E.E. 19603.

Poa annua L., E.E. 15971, 16503, 19569.

Polypogon viridis (Gouan) Breistr., E.E. 16091, 16310, 19575; TEX 142471.

Rhynchelytrum repens (Willd.) C.E. Hubb., E.E. 16150, 16249, 16714, 16848, 18876, 18979; G.H. 24435, 24990.

Schizachyrium cirratum (Hack.) Wooton & Standl. var. *cirratum*, TEX 75508.

Setaria grisebachii E. Fourn., E.E. 19297; TEX 75855, 75856, 75901.

Setaria leucophylla (Scribn. & Merr.) K. Schum., LL 170007, 170008; TEX 170004.

Setaria parviflora (Poir) Kerguelén, E.E. 16254, 19692, 18872, 18976, 18990; TEX 75797.

Setaria scheelei (Steud.) Hitchc., TEX 170115.

Sorghastrum brunneum Swallen, J.V. 8596; TEX 170265.

Sorghum halepense (L.) Pers., E.E. 16122.

Sporobolus buckleyi Vasey, TEX 170438.

Sporobolus indicus (L.) R. Br. var. *indicus*, E.E. 16192, 16624, 16778, 18868, 19098, 19122, 19178; LL 170530; TEX 170510, 170504, 170529.

Stipa clandestina Hack., LL 170560.

Stipa eminens Cav. Benth., E.E. 16287.

Stipa leucotricha Trin. & Rupr., TEX 170648.

Stipa mucronata Kunth, TEX 170669.

Tragus berteronianus Schult., E.E. 16722.

Tridens muticus (Torr.) Nash, E.E. 16686.

Tridens texanus (S. Watson) Nash, TEX 158168, 158169, 158173.

Tripsacum dactyloides (L.) L., TEX 158238.

Potamogetonaceae

Potamogeton illinoensis Morong, TEX 142176.

Potamogeton nodosus Poir., TEX 142189.

Smilacaceae

Smilax aristolochiifolia Mill., G.H. 25938.

Smilax bona-nox L., E.E. 16233, 19341; J.V. 7135; LL 177225.

Smilax glauca Walter, TEX 177270.

Smilax lanceolata L., LL 177310.

Smilax moranensis M. Martens & Galeotti, E.E. 19357.

Zannichelliaceae

Zannichellia palustris L., TEX 142247.

DICOTYLEDONEAE

Acanthaceae

Anisacanthus quadrifidus (Vahl) Nees var. *wrightii* (Torr.) Henr., LL 105860; TEX 105873: E.E. 16548; G.H. 17824.

Beloperone fulvicoma (Schltdl.& Cham.) A.W. Hill, TEX 88507.

Carlowrightia parviflora (Buckley) Wassh., TEX 87753.

Dyschoriste poliodes Leonard & Gentry var. *obispoensis* Henr., TEX 880012.

Dyschoriste schiedeana (Nees.) Kuntze var. *schiedeana* (Nees.)

Kuntze, E.E. 19680; G.H. 24360, 24415, 25450, 25611, 25914; TEX 88087.
Elytraria bromoides Oerst. Michx, E.E. 19690.
Jacobinia incana (Nees.) Hemsl., E.E. 13303; G.H. 24143, 24971; LL 88354; TEX 88332, 88335, 88348.
Justicia pilosella (Nees.) Hilsenb, TEX 88614.
Justicia turneri Hilsenb, TEX 88686, 88688.
**Mirandea huastescensis* T.F. Daniel, TEX 88750.
Ruellia corzoi Tharp & Barkley, TEX 88853, 88855, 88856, 88858, 88860.
Ruellia malacosperma Greenm., TEX 88963, 88965, 88967.
Ruellia nodiflora var. *runyonii* TEX 89013.
Ruellia occidentalis (A. Gray) Tharp & F.A. Barkley, E.E. 16676; G.H. 24411; LL 89035; TEX 89032, 89041, 89047, 89048, 89051.
Ruellia parryi A. Gray, LL 89090.
Ruellia yucatana (Leonard) Tharp & Barkley, TEX 89186.
Siphonoglossa canbyi (Greenm.)Hilsenb, TEX 89280.
Tetramerium nervosum Nees., E.E. 16062, 16574; G.H. 24224; TEX 89411, 89419.

Adoxaceae

Sambucus nigra L. ssp *canadensis* (L.) R. Bolli, G.H. 24175; TEX 78104, 78105.
Sambucus nigra L. ssp *cerulea* (Raf.) R. Bolli, E.E. 16512; TEX 78159, 78160, 78165.

Amaranthaceae

Amaranthus palmeri S. Watson, E.E. 16550, 16559.
Amaranthus spinosus L., E.E. 16198.
Celosia nitida Vahl, TEX 173682.
Froelichia arizonica Thornber ex Standl., G.H. 25902.
Iresine calea Standl., E.E. 13305, 16004.
Iresine orientalis G.L. Nesom, E.E. 16207; LL 49715; TEX 49724, 49725.
Iresine palmeri (S.Watson) Standl., TEX 49727, 49729, 49730, 49741.

Anacardiaceae

Pistacia texana Swingle, E.E. 18869; LL 103225; TEX 103223, 103232.
Rhus aromatica Aiton, LL 103289; TEX 103292, 103319, 103344.
Rhus lanceolata (A. Gray) Britton, TEX 103392.
Rhus muelleri Standl. & Barkley, E.E. 16436, 19026; G.H. 24404, 24937, 24965, 25584; TEX 103473, 103476.
Rhus pachyrrhachis Hemsl., TEX 103504.
Rhus virens A. Gray var. *virens*, G.H. 24984; LL 103813; TEX 103811, 103812, 103816.
Rhus virens Lindh. var. *choriophylla* (Woot. & Standl.) L.D. Benson; TEX 103776.
Toxicodendron radicans (L.) Kuntze ssp. *divaricatum* (Greene) Gillis, E.E. 16579, 19502; G.H. 24124, 24127; TEX 103568, 103569, 103572, 103573.

Apiaceae

Apium graveolens L., E.E. 16074.
Apium leptophyllum (Pers.) F. Muell., TEX 162084.
Arracacia ternata Mathias & Constance, TEX 162296.
Arracacia atropurpurea (Lehm.) Benth. & Hook. ex Hemsl., E.E. 19606.
Cicuta maculata L., E.E. 16124; G.H. 24406.
Coriandrum sativum L., E.E. 16067.
Daucus carota L., E.E. 16428; G.H. 24146, 24397; TEX 162462.
Daucus montanus Spreng, TEX 162468.
Daucus pusillus Michx, TEX 255245.
Donnellsmithia ternata (Walter) Mathias & Constance, TEX 162519.
Eryngium longifolium Cav., G.H. 24338.
Eryngium venustum Bartlett, TEX 163004.
Hydrocotyle verticillata Thunb., E.E. 16304.
Prionosciadium humile Rose, G.H. 24337; TEX 163257, 163260, 163265.
Sanicula liberta Cham. & Schltdl., 24137, TEX 163390.
Tauschia bicolor Constance & Bye., E.E. 15994.
Torilis arvensis (Huds.) Link, G.H. 24424.

Apocynaceae

Asclepias angustifolia Schweigg., E.E. 16575; LL 184330; TEX 184332, 184336.
Asclepias curassavica Griseb, G.H. 17829; TEX 184400, 184401, 184402.
Asclepias linaria Cav., E.E. 16319, 19487; TEX 184525, 184536.
Asclepias mexicana Cav., TEX 184633.
Asclepias oenotheroides Cham. & Schltdl., TEX 184644.
Asclepias similis Hemsl., E.E. 16141, 16496, 16530.
Asclepias subverticillata (A. Gray) Vail, TEX 184758.
Asclepias tuberosa L., E.E. 16629, 16481; LL 184802; TEX 184797, 184798.
Cynanchum kunthii (Decne.) Standl., E.E. 16318; G.H. 24347; TEX 101640.
Cynanchum pringlei (A. Gray) Henr., G.H. 25477.
Cynanchum racemosum (Jacq.) Jacq. TEX 101777.
Marsdenia pringlei S. Watson, E.E. 19428.
Matelea reticulata (Engelm. ex A. Gray) Woodson, TEX 155199, 255410.
Sarcostemma torreyi (A. Gray) Woodson, LL 155434; TEX 155400.
Apocynum cannabinum L., G.H. 24340; TEX 255246.
Mandevilla foliosa (Muell. Arg.) Hemsl., E.E. 14652.
Vinca major L., E.E. 15977; TEX 173682.

Aquifoliaceae

Ilex braegeana Loes., TEX 214669.
Ilex rubra S. Watson, E.E. 11806; TEX 232490.

Aristolochiaceae

Aristolochia elegans Mast, TEX 109344.

Asteraceae

Achillea millefolium L. var. *pacifica* (Rydb.) G.N.Jones, E.E. 16155, 16301; TEX 62211, 62220, 62229.
Acmella repens (Walter) R.K. Jansen, E.E. 13357, 16244.
Ageratina calaminthifolia (Kunth) R.M. King & H. Rob., G.H. 24951.
Ageratina spinosarum (DC.) R.M. King & H. Rob. var. *subintegrifolia* (B.L. Rob.) B.L. Turner, TEX 51616.
Ageratina gypsophila B.L. Turner, TEX 85918, 85919, 85920, 85921.
Ageratina havanensis (Kunth) R.M. King & H. Rob., G.H. 24948, 24956, 24992; LL 51768, 51781.
Ageratina herbacea (A. Gray) R.M. King & H. Rob., E.E. 19006.
Ageratina nesomii B.L. Turner, TEX 52301, 52304.
Ageratina petiolaris (DC.) R.M. King & H. Rob., E.E. 16022; TEX 52544.
Ageratina pichinchensis (Kunth) R.M. King & H. Rob., G.H. 24116; LL 52674; TEX 52672, 52677.
Ageratina saltillensis (B.L. Rob.) R.M. King &H. Rob., G.H. 24936; J.V. 8579; LL 52847; TEX 191163.
Ageratina scorodonioides (A. Gray) R.M. King & H. Rob., J.V. 8590.
Ageratina viburnoides (DC.) R.M. King & H. Rob. TEX 53074.
Ageratina wrightii (A. Gray) R.M. King & H. Rob., G.H. 24953.
Ageratum corymbosum Zucc., E.E. 18900; TEX 53235, 53241.
Ambrosia artemisiifolia L., E.E. 16429, 18969.
Ambrosia confertiflora DC., G.H. 24973; TEX 121102.
Ambrosia psilostachya DC., E.E. 16464, 16849; TEX 121520, 121522.
Aphanostephus ramosissimus DC. var. *ramosissimus*, E.E. 18994; G.H. 17827.
Artemisia ludoviciana Nutt., E.E. 19011; G.H. 24946.
Aster ericoides L., E.E. 18997; J.V. 8582.
Astranthium integrifolium (Michx.) Nutt., E.E. 15969; TEX 68086, 68084.
Baccharis crassicuneata G.L. Nesom, LL 68365; TEX 68362.

Baccharis neglecta Britton, TEX 68566.
Baccharis salicifolia Pers., E.E. 16733; LL 68743; TEX 68740, 68741, 68742, 68745.
Baccharis salicina A. Gray, E.E. 16695, 16738.
Bahia absinthifolia Benth. *var. dealbata* (A. Gray) A. Gray, TEX 55671.
Bahia autumnalis W.L. Ellison, G.H. 24987, 25900; J.V. 8568; TEX 55697, 55708.
Bidens aurea Sherff, TEX 122066.
Bidens odorata Cav., E.E. 16058, 16605, 18936, 19001.
Brickellia eupatorioides (L.) Shinners var. *chlorolepis* (Wooton & Standl.) B.L. Turner, G.H. 24939.
Brickellia grandiflora (Hook.) Nutt., E.E. 19022; J.V. 8591; TEX 114182, 114192, 114194, 191162.
Brickellia laciniata A. Gray, E.E. 11298, 11304; G.H. 24942.
Brickellia lemmonii A. Gray, *var. nelsonii* (B.L. Rob.) B.L. Turner, E.E.11286; G.H. 25920.TEX 114393, 114395, 114400, 114401.
Brickellia secundiflora A. Gray var. *parryi* (A. Gray) B.L. Turner, 1989, G.H. 25579.
Brickellia veronicifolia (Kunth) A. Gray, G.H. 24938, 24945; TEX 114930, 114971.
**Cacalia sundbergii* B.L. Turner, E.E. 19350.
Calea ternifolia Oliv. var. *calyculata* (Kunth) Wussow, J.V. 8678; TEX 123123.
Calyptocarpus vialis Less., E.E. 16188, 16196, 19345; G.H. 24354; TEX 123396, 123408, 123418, 123418, 123422, 123423.
Carduus tenuiflorus Curtis, G.H. 24105.
Centaurea americana Nutt., E.E. 16184; TEX 64265, 64266.
Chaetopappa bellioides (A. Gray) Shinners, TEX 69240, 69244, 69250, 69254.
Chaptalia lyratifolia Burkart, G.H. 25927.
Chaptalia texana Greene, E.E. 11292, 19103; G.H. 25570; TEX 66381, 66389, 66399.
Chaptalia transiliens G.L. Nesom, J.V. 8562.
Chromolaena odorata (L.) R.M. King & H. Rob., E.E. 16214; J.V. 8697; LL 115456, 115457; TEX 115448, 115455.
Chrysactinia mexicana A. Gray, E.E. 16099, 19485; TEX 56051.
Chrysactinia pinnata S. Watson, TEX 56104, 56109, 56113.
Chrysactinia truncata S. Watson, E.E. 16478, 19277; G.H. 24369; LL 56127; TEX 56130, 56132, 56133, 56134, 306063.
Chrysanthemum leucanthemum L., J.V. 7105; TEX 62467, 62468.
Chrysanthemum parthenium (L.) Pers., E.E. 16064, 16162, 16620.
Chrysanthemum procumbens (L.) Sessé & Moc. TEX 133247.
Cirsium acrolepis (Petr.) G.B. Ownbey, G.H. 24229.
Cirsium pringlei (S. Watson) Petr., E.E. 14684, 16298; G.H. 24339.
Cirsium texanum Buckley, G.H. 24235.
Conoclinium betonicifolium (Mill.) R.M. King & H. Rob. *var. integrifolium* (A. Gray) Patt., TEX 115811, 115820.
Conyza canadensis var. canadensis (L.) Cronquist, E.E. 14854, 16749a, 18984; TEX 69584, 69608.
Cosmos bipinnatus Cav., E.E. 19007.
Cosmos crithmifolius Kunth TEX 123979, 123980, 123981.
Dahlia coccinea Cav., E.E. 16562, 19035; TEX 124384, 124390.
Dahlia tubulata P.D. Sorensen, LL 136829; TEX 136833.
Dichaetophora campestris A. Gray, TEX 70037, 70041.
Dyssodia papposa Hitchc., G.H. 25574, 25575.
Dyssodia pinnata B.L. Rob., E.E. 11288, 16149, 16416, 16850, 18862, 19279.
Dyssodia pinnata B.L. Rob. var. *glabrescens* Strother, G.H. 24353, 24943.
Erigeron basilobatus S.F. Blake, E.E. 16289, 16297; TEX 70153, 70154, 70155.
Erigeron calcicola Greenm., G.H. 24949, 25460; LL 70256; TEX 70264.
Erigeron dryophyllus A. Gray, J.V. 7118; TEX 70527, 70532, 70533, 98262.
Erigeron metrius S.F. Blake, G.H. 24118. LL 137168; TEX 137170, 137171.
Erigeron veracruzensis G.L.Nesom LL 71049, 71050; TEX 71051, 71053, 71057, 71058.
Evax verna Raf., TEX 139453, 139459.
Flaveria trinervia (Spreng.) C. Mohr, TEX 56808.
Fleischmannia porphyranthema (A. Gray) R.M. King & H.Rob, TEX 116453, 116457, 116458, 116469.
Fleischmannia pycnocephala (Less.) R.M. King & H.Rob, E.E. 19250; TEX 191169.
Florestina triperis DC., E.E. 16677.
Flourensia cernua DC., E.E. 18745.
Flourensia monticola M.O. Dillon, G.H. 24950; TEX 125157, 125158, 125162, 125165.
**Flyriella leonensis* (B.L. Rob.) R.M. King & H. Rob., E.E. 16300; J.V. 7117; LL 116730, 116733; TEX 116731, 167132, 116734, 116735, 116736.
Gaillardia mexicana A. Gray, E.E. 16459, 11306; J.V. 8578; TEX 57249, 57256, 57251, 191164.
Gaillardia pulchella Foug., E.E. 16012.
Gamocheta americana (Mill.) Cabrera, TEX 139489.
Gnapahliopsis micropoides DC., TEX 58260, 58292.
Gnaphalium brachypterum DC., G.H. 25473, 25921, 25945.
Gnaphalium semiamplexicaule DC., E.E. 16191.
Gochnatia hypoleuca (DC.) A. Gray, E.E. 19476; TEX 66489.
Greenmaniella resinosa (S. Watson) W.M. Sharp, TEX 125462, 125466, 125467, 125470 125473, 125476, 306201.
Grindelia greenmanii Steyerm., G.H. 24957.
Grindelia tenella Steyerm., TEX 136693, 136696.
Gutierrezia microcephala (DC.) A. Gray, LL 71378; TEX 71384.
Gutierrezia sarothrae (Pursh) Britton & Rusby, G.H. 25919; TEX 71447.
Gutierrezia texana (DC.)Torr. & A. Gray var. *glutinosa* (S. Schauer) M.A. Lane, TEX 71549, 71554, 71560, 71566, 71570.
Gymnosperma glutinosa Less., E.E. 11283, 16081, 18999, 19270; G.H. 25476; TEX 71783 71794, 71800, 71802, 71805, 71809.
Haploesthes greggii A. Gray var. *multiflora* I.M. Johnst., LL 57488; TEX 57489.
Helenium elegans DC. var. *amphibolum* (A. Gray) Bierner, LL 57553; TEX 57537, 57538, 57551.
Helenium microcephalum DC. var. *ooclinium* (A. Gray) Bierner, E.E. 16210, 16549, 16667; G.H. 24106, 24172.
Helianthus annuus L., G.H. 24169, TEX 125724.
Helianthus hirsutus Raf., LL 125762, TEX 125756.
Helianthus laciniatus A. Gray, E.E. 14703, 14710.
Heliopsis parvifolia A. Gray, G.H. 24935, 25909.
Heterotheca mucronata Harms ex B.L. Turner, E.E. 16317, 16684; TEX 71972, 71985, 71992, 86351.
Heterotheca subaxillaris (Lam.) Britton & Rusby, E.E. 14838, 14876, 16148; 16154, 16753, 18863, 18871; G.H. 24426, 24986; LL 136421; TEX 136418, 136419, 136422, 136423, 136440.
Hieracium abscissum Lees., E.E. 16537; LL 64776; TEX 64774, 64788.
Hieracium crepidispermum Fries, G.H. 25569.
Hieracium gypsophilum B.L. Turner, G.H. 25491; TEX 64973, 64978, 64989.
Hymenoxys linearifolia Hook., E.E. 16060.
Hymenoxys scaposa (DC.) Parker, E.E. 16014.
Iva ambrosiifolia (A. Gray) A. Gray, TEX 126384.
Jefea brevifolia (A. Gray) Strother, G.H. 25908.
Koanophyllon longifolium (B.L.Rob.) R.M. King & H. Rob., J.V. 8593, 8668; TEX 117192.
Koanophyllon reyrobinsonii B.L. Turner, TEX 117055, 117057, 117065, 191155.
Lactuca ludoviciana (Nutt.) Riddell, E.E. 16175, 16346; LL 65132; TEX 65125, 65130, 65135.

Lactuca sativa L., E.E. 16076.
Laennecia schiedeana (Less.) G.L.Nesom, TEX 69916.
Laennecia sophiifolia (Kunth) G.L.Nesom, TEX 69975, 69976, 69977.
Machaeranthera pinnatifida (Hook.) Shinners var. *pinnatifida*, G.H. 24428.
Machaeranthera tanacetifolia (Kunth) Nees, J.V. 1253.
Matricaria chamomilla L., E.E. 16065.
Melampodium divaricatum (Rich) DC., E.E. 16647, 19403.
Osbertia bartletti (S.F. Blake) G.L. Nesom, TEX 138631.
Palafoxia texana DC. var. *texana* DC., TEX 59294, 59295.
Parthenium confertum A. Gray, E.E. 16660.
Parthenium confertum A. Gray var. *lyratum* (A. Gray) Rollins, TEX 129617.
Parthenium hysterophorus L., E.E. 15968, 16698; TEX 129738, 129742.
**Parthenium lozanianum* Bartlett, TEX 373935.
Peteravenia malvaefolia (DC.) R.M. King & H. Rob., TEX 117656, 117657, 117658, 117665.
Pinaropappus roseus (Less.) Less. var. *macvaughii*, TEX 65367, 65376, 65385.
Piqueria trinervia Cav., TEX 117863.
Pluchea carolinensis (Mill.) Gillis, G.H. 17832; LL 141593; TEX 141592, 141594, 141595.
Porophyllum amplexicaule Engelm ex A. Gray, G.H. 22155.
Porophyllum scoparium A. Gray, E.E. 19506; G.H. 17825, 24989, 25475; LL 60639; TEX 60638.
Psacalium peltatum (Kunth) Cass. var. *adenophorum* S.F. Blake, TEX 86015, 86021.
Pseudognaphalium austrotexanum G.L.Nesom, TEX 139783.
Pseudognaphalium brachypterum (DC.) Anderb., TEX 139822, 139823.
Pseudognaphalium canescens (DC.) Anderb., TEX 139852.
Pseudognaphalium roseum (Kunth) Anderb., TEX 141284.
Pseudognaphalium viscosum (Kunth) Anderb. LL 141507.
Psilactis tenuis S. Watson, E.E. 16635; LL 138891, TEX 138889.
Psilostrophe gnaphalodes DC., TEX 60791.
Pyrrhopappus pauciflorus (D. Don) DC., E.E. 15954; G.H. 24107; LL 65556.
Ratibida columnifera (Nutt.) Wooton & Standl., E.E. 14640, 16106, 16400.
Roldana sundbergii (B.L. Turner) B.L. Turner, LL 62998; TEX 62995.
Rumfordia alcortae Rzed., TEX 130643.
**Rumfordia exauriculata* B.L. Turner, TEX 130656.
**Sabazia mullerae* S.F. Blake, TEX 373978.
Sanvitalia ocymoides DC., E.E. 16680.
Schkuhria pinnata (Lam.) Kuntze ex Thell. var. *guatemalensis* (Rydb.) McVaugh, G.H. 25573.
Sclerocarpus uniserialis Benth. & Hook. F. var. *frutescens* (Brandegee) Feddema, E.E. 16144, 16427, 18893, 18998; TEX 131399, 131401, 131406.
Senecio coahuilensis Greenm., E.E. 13308, 13373, 14672, 15960, 16288, 16307; TEX 63800, 63822, 63830.
Senecio loratifolius Greenm., TEX 64086.
Senecio madrensis A. Gray, TEX 64124, 64133.
Senecio montereyanus S. Watson, E.E. 16357; J.V. 7110; TEX 63865, 63867.
**Senecio pattersonii* B.L. Turner, TEX 31160.
Senecio platypus Greenm., J.V. 8587; TEX 191163.
Senecio richardsonii B.L. Turner, TEX 63738, 63746.
Senecio salignus DC., E.E. 16019, 19499; TEX 63324, 63326.
Senecio tampicanus DC. E.E. 16449.
Senecio vulgaris L., TEX 63660.
Simsia amplexicaulis (Cav.) Pers., G.H. 25578; TEX 131749, 131751.
Simsia calva (A. Gray & Engelm) A. Gray, E.E. 11362, 14877.
Simsia eurylepis S.F. Blake, TEX 131891.
Smallanthus uvedalius (L.) Mack. ex Small, E.E. 19294; TEX 54471, 132117.
Solidago altissima L., E.E. 16646; TEX 138898.
Solidago hintoniorum G.L. Nesom, E.E. 16431; TEX 138936.
Solidago juliae G.L. Nesom, LL 138943.
Solidago pringlei Fernald, TEX 138977, 138978.
Sonchus oleraceus L., E.E. 16057, 16173, 16407, 16841, 18937.
Stevia berlandieri A. Gray var. *berlandieri*, E.E. 14625, 14702, 15200, 16131, 16529; G.H. 24162; LL 120167, 120168; TEX 120161, 120163, 120169, 120170, 120190, 120191, 120205.
Stevia ovata Willd., E.E. 18965, 19148; J.V. 8569, 8667.
Stevia pilosa Lag., TEX 119561.
Stevia porphyrea McVaugh, LL 119527.
Stevia salicifolia Cav. var. *salicifolia*, TEX 119793.
Symphyotrichum carnerosanum (S. Watson) G.L. Nesom, G.H. 24941. LL 67557; TEX 67561, 67562, 67563.
Symphyotrichum expansum (Poepp. ex Spreng.) G.L. Nesom, TEX 67638, 67639, 67652.
Tagetes lucida Cav., E.E. 11309a, 16098, 16365, 16492a, 19003; LL 61537.
Tamaulipa azurea (DC.) R.M. King & H. Rob., TEX 118130, 118142, 118144, 118149.
Taraxacum officinale F.H. Wigg., E.E. 15953, 16426.
Tetraneuris linearifolia Greene var. *linearifolia*, G.H. 24335; TEX 58941, 58943, 58944, 58948, 58967.
Tetraneuris scaposa Greene var. *scaposa*, G.H. 25925.
Thelesperma longipes A. Gray, G.H. 25937.
Thelesperma megapotamicum (Spreng.) Kuntze var. *megapotamicum*, G.H. 25456.
Thelesperma subaequale S.F. Blake, G.H. 25947; TEX 85679.
Thymophylla acerosa (DC.) Strother, E.E. 13245.
Thymophylla pentachaeta (DC.) Small var. *pentachaeta*, E.E. 13366, 16696; G.H. 24348; TEX 58660, 58674, 58690, 58695, 58714.
Thymophylla setifolia Lag., TEX 58238.
Tridax coronopifolia (Kunth) Hemsl., TEX 132940.
Trixis inula Crantz, TEX 66807.
Verbesina chihuahuensis A. Gray, TEX 133862.
Verbesina coahuilensis A. Gray ex S. Watson, G.H. 24367; TEX 134437, 134438, 134440, 134442, 134443.
Verbesina daviesiae B.L. Turner, TEX 134053, 134055.
Verbesina encelioides (Cav.) Benth. & Hook. ex A. Gray, G.H. 22184, 24995.
Verbesina hypomalaca B.L. Rob. & Greenm. var. *saltillensis* B.L. Turner, G.H. 25455.
Verbesina longipes Hemsl., G.H. 25464; J.V. 8580.
Verbesina microptera DC., G.H. 24962.
Verbesina mollis Kunth, J.V. 8581; TEX 134394, 184227.
**Verbesina olsenii* B.L. Turner, E.E. 16756; TEX 134874, 134876, 134879, 134882.
Verbesina persicifolia DC., G.H. 24991; J.V. 8699; LL 134685; TEX 134686, 134692, 134693.
**Verbesina zaragozana* B.L. Turner, TEX 134362.
Vernonia greggii A. Gray var. *greggii*, E.E. 14631, 16428.
Vernonia greggii A. Gray var. *ervendergii* (A. Gray) B.L. Turner, G.H. 24114, 24117; J.V. 8666; LL 50309, 50311; TEX 50294, 50295, 50297, 50303, 50305, 50616.
**Vigethia mexicana* (S. Watson) Weber, E.E. 15950; G.H. 24104, 24131; LL 135091, 135097; TEX 135088, 135096, 135099, 135108, 135109, 135110, 135115, 135117.
Viguiera adenophylla S.F. Blake, J.V. 8682; TEX 135350, 135351, 135360.
Viguiera cordifolia A. Gray var. *latisquama* Greenm., G.H. 25465.
Viguiera dentata (Cav.) Spreng *var. dentata*, TEX 135507.
Wedelia acapulcensis Kunth var. *hispida* (Kunth) J.L. Strother, E.E.

14624, 14852, 18913; G.H. 24359; TEX 54150, 54207.
Wedelia ayerscottiana B.L. Turner, G.H. 25472; TEX 54101.
Zaluzania megacephala Sch. Bip., LL 54473, TEX 54471.
Wyethia mexicana S. Watson, TEX 374131.
Zinnia peruviana (L.) L., E.E. 16411, 16743, 16839; G.H. 24431.

Balsaminaceae

Impatiens capensis Meerb., E.E. 16120; G.H. 25468; TEX 264705.

Basellaceae

Anredera scandens (L.) Moq., E.E. 16158, 16618; TEX 258823, 258825, 258838.

Begoniaceae

Begonia uniflora S. Watson, E.E. 19079, 19353; J.V. 8683; TEX 181761, 181765, 181772.

Berberidaceae

Berberis eutriphylla (Fedde) C.H. Muller TEX 240894;
Berberis gracilis Benth. var. *madrensis* Marroq., E.E. 16322, 19259, 19599; TEX 240918, 240922, 240925, 240931.
Berberis trifoliolata Moric, E.E. 19484; TEX 247023.

Betulaceae

Carpinus caroliniana Walter, TEX 171665.
Ostrya virginiana (Mill.) K. Koch, ssp. *virginiana* K. Koch, E.E. 16460, 19163; TEX 171736, 171738.

Bignoniaceae

Chilopsis linearis (Cav.) Sweet var. *tomenticaulis* Henr., E.E. 16151.
Tecoma stans (L.) Juss. ex Kunth, E.E. 16123, 16792; G.H. 24968; TEX 104857, 104918, 104941.

Boraginaceae

Cordia boissieri A. DC., E.E. 16712; LL 224208, 224222; TEX 224197, 224203, 224209.
Cryptantha mexicana (Brandegee) I.M. Johnst, LL 224939; TEX 224931.
Ehretia anacua (Teran & Berla.) I.M.Johnst., E.E. 19694; TEX 225039, 225055.
Heliotropium angiospermum Murray, LL 225146, 225177, 306824; TEX 225145, 225148:
Heliotropium calcicola Fernald, G.H. 22186.
Heliotropium confertifolium (Torr.) A. Gray, TEX 225282.
Heliotropium fruticosum L., G.H. 24452.
Heliotropium glabriusculum (Torr.) A. Gray, TEX 225457.
Heliotropium procumbens Mill., E.E. 16672.
Heliotropium torreyi I.M. Johnst., G.H. 17831; TEX 225731, 225736, 225737, 225740.
Lithospermum calcicola B.L. Rob., G.H. 25582, 25932; TEX 225833.
Lithospermum calycosum (J.F. Macbr) I.M. Johnst., TEX 255136.
Lithospermum distichum Ortega, G.H. 24376.
Lithospermum mirabile Small, TEX 225966.
**Lithospermum nelsonii* Greenm., TEX 223064, 225982.
Lithospermum palmeri S. Watson, G.H. 24393.
Lithospermum viride Greene, LL223060; TEX 223054, 223062, 223053.
Macromeria barbigera I.M.Johnst., LL 192103; TEX 192101.
Macromeria leonitis I.M. Johnst., E.E. 19613.
Omphalodes cardiophylla A. Gray ex Hemsl., E.E. 16782, 19081; G.H. 24342, 24454, 25906; TEX 223079, 223084.
Omphalodes mexicana S. Watson, E.E. 18942.
**Onosmodium dodrantale* I.M. Johnst., J.V. 8564.
Tiquilia canescens (DC.) A.T. Richardson, E.E. 21324.

Brassicaceae

Brassica campestris L., E.E. 16089; TEX 147742.
Brassica juncea (L.) Czern., TEX 147721.
Brassica nigra W.D.J. Koch, TEX 147726.
Brassica rapa L., TEX 147742.
**Cardamine auriculata* S. Watson, LL 147809; TEX 147786, 147792, 147796, 147801, 147802, 147803, 147805, 147807.
Cardamine macrocarpa Braegee, E.E. 19467; TEX 147820, 147816.
Diplotaxis muralis (L.) DC., E.E. 16413.
Eruca sativa Mill., E.E. 16010; TEX 148091.
Erysimum asperrimum (Greene) Rydb., G.H. 24344; LL 148121; TEX 148112, 148115, 148108.
Erysimum asperrimum DC., E.E. 15992.
Erysimum capitatum (Douglas ex Hook.) Greene, E.E. 14882.
Lepidium austrinum Small, TEX 148243, 148245.
Lepidium lasiocarpum Nutt., E.E. 15967; LL 148222.
Lepidium virginicum L. var. *pubescens* (Greene) C.L. Hitchc., E.E. 16430; TEX 148341.
Lesquerella inflata Rollins & E.A. Shaw, TEX 148551.
Lesquerella lasiocarpa (A. Gray) S. Watson, E.E. 19327.
Lunaria annua L., E.E. 14628, 16140, 18897, 18934.
Lunaria rediviva L., E.E. 16002.
Physaria mirandiana (Rollins) O'Kane & Al-Shehbaz, E.E. 16392.
Rorippa mexicana (Moc., Sessé & Cerv. D.C.) Standl. & Steyerm, E.E. 16501, 16780.
Rorippa nasturtium-aquaticum (L.) Schinz & Thell., E.E. 16539, 16787, 18932; TEX 148581, 149085, 149086.
Sisymbrium auriculatum A. Gray, E.E. 13318.
Sisymbrium longipes Rollins, TEX 371009.
Sisymbrium irio L., E.E. 18970, 18980.
Synthlipsis greggii A. Gray, LL 149313.
Thelypodium longipes (Rollins) Rollins, E.E. 16741.

Cactaceae

Cylindropuntia imbricata (Haw.) F.M. Knuth., E.E. 19619.
Cylindropuntia leptocaulis (DC.) F.M. Knuth, E.E. 12654.
Echinocereus enneacanthus Engelm., E.E. 19626.
Echinocereus pentalophus (DC.) Lem. ssp. *leonensis* (Mathsson) N.P. Taylor, TEX 181897.
Echinocereus reichenbachii (Terscheck) Britton & Rose, E.E. 19628, 19631.
Echinocereus stramineus (Engelm.) Rumpler, E.E. 19632.
**Echinocereus viereckii* Werderm ssp. *morricalii* (Riha) N.P.Taylor, TEX 181913, 181914.
Epithelantha micromeris (Engelm.) F.A.C. Weber ex Britton &Rose, TEX 181947.
Ferocactus hamatacanthus (Muehlenpf.) Britton & Rose, E.E. 19629.
Ferocactus pilosus (Galeotti) Werderm., E.E. 19505.
Mammillaria chionocephala J.A. Purpus, E.E. 19625.
Mammillaria melanocentra Poselger, TEX 271027.
Mammillaria prolifera (Mill.) Haw. ssp. *texana* (Engelm.) D.R. Hunt., E.E. 19627.
Mammillaria winterae Boed., E.E. 19630.
Neolloydia conoidea (DC.) Britton & Rose, E.E. 19624.
Opuntia lindheimeri Engelm., E.E. 19618, 19621, 19639.
Opuntia microdasys (Lehm.) Pfeiff., E.E. 19622.
Opuntia stenopetala Engelm., E.E. 19617.
Selenicereus spinulosus (DC.) Britton & Rose, E.E. 16522.
Thelocactus bicolor (Galeotti ex Pfeiff.) Britton & Rose, TEX 271371.
Turbinicarpus beguinii (N.P. Taylor) Mosco & Zanovello ssp. *beguinii* (N.P. Taylor) Mosco & Zanovello, G.H. 27208, 27828.

Campanulaceae

Campanula rotundifolia L., E.E. 16444.
Lobelia calcarea E. Wimm., TEX 80118.
Lobelia cardinalis L., E.E. 16168; TEX 80137, 80141, 80143, 80146, 80147.
**Lobelia sublibera* S. Watson, E.E. 16369, 16551; G.H. 24129, 24234; TEX 80519, 80521, 80522, 80523, 80544.

Triodanis coloradoensis (Buckley) McVaugh, TEX 80604.

Caparaceae

Koeberlinia spinosa Zucc., E.E. 19482.

Polanisia dodecandra (L.) DC., TEX 149928.

Polanisia uniglandulosa DC., E.E. 14883, 16121, 16394; G.H. 24429, 24974; TEX 149906.

Caprifoliaceae

Abelia coriacea Hemsl. var. *subcoriacea* Villarreal., TEX 245831, 245833.

Lonicera japonica Thunb., E.E. 16044.

Lonicera pilosa (Kunth) Willd., E.E. 16344.

Symphoricarpus microphyllus Kunth, TEX 78256.

Symphoricarpos orbiculatus Moench, LL 78258.

Caryophyllaceae

Arenaria benthamii Fenzl ex Torr. & A. Gray, TEX 239096.

Arenaria lanuginosa Rohrb. var. *saxosa* (A. Gray) B.L. Turner, E.E. 16312, 16316, 16487; TEX 258961.

Arenaria lycopodioides Willd. ex Schltdl., E.E. 13339.

Drymaria barkleyi Duke & Steyerm., TEX 239270.

Drymaria glandulosa Bartl., TEX 239450.

Drymaria laxiflora Benth., LL 239365; TEX 239364.

Saponaria officinalis L., G.H. 24341; TEX 256067.

Silene laciniata (A. Gray) Hitchc., E.E. 16109, 16178, 16306, 16746, 18934a.

Silene laciniata Cav. var. *greggii* (A. Gray) S. Watson, E.E. 16109, 16178, 16306, 16746, 18934a; LL 239569; TEX 239562, 239563, 239565.

Stellaria cuspidata Willd., E.E. 13298, 13367; G.H. 24112; LL 239689; TEX 239675, 239693, 239694, 239696, 239698, 239705.

Celastraceae

Mortonia greggii A. Gray, E.E. 19478.

Celtidaceae

Celtis laevigata Willd., E.E. 14858, 16220; G.H. 24969.

Celtis pallida Torr., E.E. 16659, 16729, 19101; TEX 216646.

Chenopodiaceae

Beta vulgaris L., E.E. 16078.

Chenopodium ambrosioides L., E.E. 16072, 16156, 16362, 16611; TEX 173020.

Chenopodium berlandieri Moq., E.E.18935, 18983.

Chenopodium graveolens Willd., E.E. 16610, 16622.

Chenopodium incidium Poir., E.E. 16554.

Chenopodium murale L., TEX 173151.

Clusacieae

Hypericum formosum Kunth, E.E. 16552.

Convolvulaceae

Convolvulus equitans Benth., G.H. 24214, 24427.

Cuscuta glabrior (Engelm.) Yunck., TEX 155643.

Cuscuta indecora Choisy, E.E. 16691; TEX 155654.

Cuscuta mitriformis Engelm., TEX 155714, 155715.

Cuscuta rugosiceps Yunck., TEX 155750.

Cuscuta tinctoria Mart. ex Engelm., TEX 155774.

Dichondra micrantha Urb., TEX 155938.

Dichondra sericea Sw., E.E. 16235, 16494, 16524; TEX 155943.

Evolvulus alsinodes Kuntze, E.E. 16697, 16724; TEX TEX 155986.

Ipomoea cristulata Hallier, E.E. 16423.

Ipomoea hederifolia L., TEX 242611.

Ipomoea nil (L.) Roth, TEX 242871.

Ipomoea orizabensis J.A. McDonald var. *collina* (House), TEX 217423.

Ipomoea purpurea Roth., E.E. 19102.

Ipomoea simulans D. Hanb, LL 217236; TEX 217234, 217235.

Cornaceae

Cornus florida L., ssp. *urbiniana* (Rose) Rickett,., E.E. 15403, 15460, 15981, 16007, 16017, 16479; J.V. 7106, LL 163718, 163724, 163726, 163733; TEX 163722, 163734, 163782; TEX 163782.

Crassulaceae

Echeveria simulans Rose, LL 168239; TEX 168235, 168240.

Echeveria strictiflora A. Gray, E.E. 13358.

Kalanchoe daigremontiana (Raym.) Hamet & Perrier, E.E. 16704.

Lenophyllum acutifolium Rose, TEX 168301.

Sedum calcicola B.L. Rob. & Greenm., TEX 168343.

Sedum diffusum S. Watson, LL 168387; TEX 168389, 168391.

Sedum palmeri S. Watson, E.E. 13299, 15996, 19438, 19457; TEX 168568, 168570, 168576, 168577.

Sedum papillicaulum G.L. Nesom, E.E. 16519.

Sedum rhodocarpum Rose, TEX 168624.

Sedum wrightii A. Gray, TEX 168675.

Villadia squamulosa (S. Watson) Rose., E.E. 19144, 19252.

Cucurbitaceae

Cucurbita foetidissima Kunth, E.E. 16398.

Cyclanthera dissecta (Torr. & A. Gray) Arn. & Hook., E.E. 18907, 18939; TEX 79157.

Melothria pendula L., E.E. 16266; TEX 79469, 79477, 79479.

Sechium edule (Jacq.) Sw., E.E. 18967.

Ebenaceae

Diospyros texana Scheele, E.E. 16252.

Ericaceae

Arbutus xalapensis Kunth, G.H. 24947; LL 276212; TEX 276100.

Arctostaphylos pungens Kunth, TEX 276393.

Chimaphila umbellata (L.) Nutt., TEX 154450.

Comarostaphylis polifolia (Kunth) Zucc., E.E. 19515, 19541.

Leucothoe mexicana (Hemsl.) Small, E.E. 15452.

Lyonia squamulosa M. Martens & Galeotti, LL 276862; TEX 276860, 276863.

Monotropa hypopithys L., E.E. 19640.

Vaccinium kunthianum Klotzsch, LL 277017; TEX 277015.

Euphorbiaceae

Acalypha dioica S. Watson, G.H. 24944, 25907; LL 215443; TEX; 215442, 215446, 215448.

Acalypha lindheimeri Müll. Arg., E.E. 16080, 16421, 15965, 16613; G.H. 25583.

Acalypha ostryifolia Riddell, TEX 215144.

Acalypha phleoides Cav., E.E. 16728; TEX 215269, 215270, 215271; TEX 215025, 215031, 215050.

Argythamnia astroplethes J.W. Ingram, TEX 90142.

Argythamnia neomexicana Müll. Arg., TEX 90225.

Bernardia myricaefolia (Scheele) S. Watson, E.E. 16206.

Cnidoscolus rotuifolius (Müll. Arg.) McVaugh, TEX 91872, 91873.

Croton ciliatoglandulifer Ortega, E.E. 13363, 14836, 15964, 16102, 16238, 19095, 19236; G.H. 24098; LL 92163; TEX 92170, 92078, 92079, 92103, 92181, 92182, 92183.

Croton dioicus Cav., TEX 92439.

Croton fruticulosus Torr., E.E. 16528, 16553, 16737, 16795, 18880, 19393, 19591, 19705; G.H. 24358; LL 92566; TEX 92552, 92558, 92582, 92591.

Croton incanus Kunth, E.E. 16576; TEX 92740.

Croton suaveolens Torr., LL 93170, 93222; TEX 93220, 93220.

Euphorbia antisyphilitica Zucc., E.E. 19477; TEX 93450.

Euphorbia campestris Cham. & Schltdl., G.H. 25944; TEX 94519, 94522, 94523, 94524, 94526.

Euphorbia cumbrae Boiss., TEX 90633.

Euphorbia cyathophora Murray, TEX 94183.

Euphorbia dentata Michx., E.E. 16564, 16750; TEX 94267, 94268.

Euphorbia fendleri (Torr.) A. Gray, E.E. 16678, 16720.
Euphorbia furcillata Kunth, E.E. 15462, 15980, 19394, 19567; G.H. 24139.
Euphorbia graminea Jacq., J.V. 8588, TEX 93634.
Euphorbia greggii Engelm. ex Boiss., G.H. 25571, 25612, 25928, 25929; TEX 94599, 94600, 94601, 94602, 94603, 94604.
Euphorbia helleri Millsp., TEX 94620.
Euphorbia heterophylla L. f. *cyathophora* (Murray) Voss, TEX 94183.
Euphorbia hyssopifolia L., E.E. 16693, 18867.
Euphorbia lathyris L., TEX 94624.
Euphorbia macropus (Klotzsch & Garke) Boiss, TEX 93838.
Euphorbia macropus (Kl. et Gke.) Boiss. var. *novoleonensis* Mayfield, G.H. 25467; TEX 93835.
Euphorbia mcvaughiana M.C. Johnst., TEX 94627.
Euphorbia montereyana Millsp., TEX 93920, 93921, 93923, 93934, 93938.
Euphorbia nutans Lag., TEX 91090, 91083, 91085.
Euphorbia prostrata Aiton, E.E. 16612, 16666, 16796.
Euphorbia serpens Kunth, TEX 91263.
Euphorbia stictospora Engelm., TEX 91465.
Euphorbia villifera Scheele, LL 91674; TEX 91660.
Gymnanthes longipes Müll. Arg., TEX 94786.
Jatropha dioica Sessé ex. Cerv., E.E. 16684; TEX 94949.
Phyllanthus neoleonensis Croizat, LL 102373; TEX 253918, 253978.
Phyllanthus polygonoides Nutt. ex Spreng., E.E. 18921; J.V. 8665, LL 102429; TEX 102418, 102419, 253970.
Ricinus communis L., E.E. 16064a, 19385; TEX 102548.
Stillingia sanguinolenta Müll. Arg., G.H. 24955, TEX 102730, 102731, 102734, 102735, 102736.
Stillingia treculiana (Müll. Arg.) I.M. Johnst., TEX 102787.
Tragia nepetaefolia Cav., G.H. 25474.

Fabaceae

Acacia berlandieri Benth., E.E. 15198, 16203; G.H. 24430; TEX 152704, 152712.
Acacia coulteri Benth., E.E. 13328, 13350, 13387, 14897, 16215, 16561; G.H. 24102, 24235; TEX 152993, 253505.
Acacia farnesiana (L.) Willd., E.E. 13331, 16706, 19370., TEX 153072.
Acacia rigidula Benth., E.E. 13333; G.H. 24982.
Acacia roemeriana Scheele, E.E. 12745, 13352; TEX 153621.
Acacia wrightii Benth. ex A. Gray, TEX 153701.
Acaciella angustissima (Mill.) Kuntze var. *angustissima* (Mill.) Kuntze, E.E. 13327, 14830, 14844, 14880, 14895, 18864, 19002; G.H. 24103; LL 152574; TEX 152571:
Acaciella villosa Willd., E.E. 14711, 16432.
Amicia zygomeris DC., E.E. 19461; TEX 191879.
Astragalus austrinus (Small)Schulz var. *austrinus* (Small)Schulz, TEX 260780, 260785.
Astragalus emoryanus (Rydb.) Cory, TEX 260780, 260785.
**Astragalus greggii* S. Watson, G.H. 24374, TEX 260841.
**Astragalus mario-sousae* E. Estrada, Villarreal & Yen, E.E. 12729.
**Astragalus regiomontanus* Barneby, E.E. 15433, 15444; TEX 260536.
Astragalus sanguineus Rydb., G.H. 24375.
Bauhinia macranthera Benth., E.E. 13319, 14867, 16105, 16798, 18878, 19169; G.H. 24230, 25915; J.V. 7129.
Caesalpinia mexicana A. Gray, E.E. 13316, 13370; G.H. 22183.
Calia secundiflora (Ortega) Yakovlev, E.E. 15197, 19168, 19512; G.H. 24981; TEX 273983, 274012, 274013, 274017.
Calliandra conferta Benth., E.E. 15214; TEX 153899.
Canavalia septentrionalis J.D. Sauer, E.E. 16275, 16558; TEX 229792, 229793, 229807, 229810.
Canavalia villosa Benth., E.E. 13353, 14642, 14683, 14837, 14874, 15207, 16350, 16748; J.V. 8583, 8680, 8691; TEX 213923, 229880.
Centrosema sagittatum Brandegee, E.E. 16224.
Centrosema virginianum (L.) Benth., E.E. 13384, 14833, 14846, 14849, 15215, 16221, 16271; G.H. 24218; TEX 223079, 229987.
Cercis canadensis L. var. *mexicana* (Rose) M. Hopkins, G.H. 25951; E.E. 19301.
Chamaecrista nictitans L. ssp. *disadena* Irwin & Barneby, E.E. 13362, 16237.
Chamaecrista greggii Pollard var. *greggii*, E.E. 14896, 15213.
Clitoria mexicana Link, E.E. 15450; LL 220049.
Cologania angustifolia Kunth, E.E. 15438; G.H. 25609.
Cologania broussonetii DC., E.E. 14671, 16744, 18909, 18923, 19183, 19364.
Coursetia caribaea (Jacq.) Lavin var. *caribaea* (Jacq.) Lavin, TEX 220126.
Coursetia glabella (A. Gray) Lavin, E.E. 16851.
Crotalaria incana L., E.E. 13311, 14857.
Crotalaria polyphylla Riley, E.E. 16523, 16625.
Crotalaria pumila Raf., E.E. 16752, 16861, TEX 253138, 253211.
Crotalaria rotundifolia (Walter) J.F. Gmel. var. *vulgaris* Windler, E.E. 16485.
Crotalaria sagittalis L, TEX 253289.
Dalea bicolor Humb. & Bonpl. In Willd. var. *bicolor* Humb. & Bonpl. In Willd., E.E. 16146, 16847, 16860.
Dalea greggii A. Gray, E.E. 13324.
Dalea hospes (Rose) Bullock, E.E. 14860, 14892, 15208, 18887, 18920; J.V. 8690, TEX 247898, 247899, 247902.
Dalea longipila (Rydb.) Cory, TEX 214042.
Dalea lutea Willd. var. *lutea* Willd., E.E. 15206, 18922; TEX 214113.
Dalea nana Torr. ex A. Gray var. *carnescens* (Rydb.) Kearney & Peebles, E.E. 15146.
Dalea pogonathera A. Gray var. *walkerae* (Tharp & F.A. Barkley) B.L. Turner, E.E. 15145; TEX 214388.
Dalea saffordii (Rose) Bullock, J.V. 7127.
Dalea scandens (Mill.) R.T. Clausen, E.E. 14706, 14863, 19119.
Dalea scandens (Mill.) R.T. Clausen var. *paucifolia* (Coult.) Barneby, E.E. 16223; LL 214464; TEX 214470.
Dalea wrightii A. Gray, E.E. 19491.
**Desmanthus pringlei* (Britton & Rose) F.J. Hermann, E.E. 14632; G.H. 24225; TEX 257182.
Desmodium angustifolium DC., E.E. 14627, 14699, 14875a.
Desmodium caripense G. Don, E.E. 16631, 19089, 19140; TEX 221779.
Desmodium glutinosum (Muhl. ex Willd.) Wood, E.E. 16367a, 16525, 16639, 18891; LL 221817.
Desmodium grahami A. Gray, E.E. 16228, 16486, 16534, 16855, 18901, 19008, 19181; G.H. 25463.
Desmodium lindheimeri Vail, E.E. 16749, 18883, 18899; J.V. 8689; TEX 221953, 221956, 221961, 221964, 221967.
Desmodium macrostachyum Hemsl., E.E. 16656; TEX 221190.
Desmodium molliculum (Kunth) D. C., E.E. 15442, 16367; TEX 221213.
Desmodium procumbens (Mill.) Hitchc, LL 221362.
Desmodium psilophyllum Schlecht., E.E. 14834, 16264, 16490, 16527, 18926, 19113; G.H. 24228; J.V. 8688; LL 221423, 221430; TEX 221424, 221434, 221435, 221437, 221443, 221444, 221445.
Desmodium retinens Schlecht., E.E. 14701, 15449, 16267, 16403, 16484, 19114, 19215.
Ebenopsis ebano (Berland.) Barneby & J.W. Grimes, E.E. 16231.
Eysenhardtia texana Scheele, E.E. 13325, 14889, 16404; G.H. 24398.
Galactia brachystachya Benth. E.E. 19504.
Galactia striata Urb., E.E. 16272.
Galactia texana A. Gray, E.E. 14865; TEX 220858.
Havardia pallens Britton & Rose, E.E. 14645, 14851, 14861, 18896; G.H. 24451, 24979, 24980; TEX 252138, 252140, 257337.
Hoffmanseggia glauca (Ortega) Eifert, E.E. 14685.
Indigofera acutifolia Schltdl., TEX 220548.
Indigofera hartwegii Rydb., E.E. 15209.

Indigofera miniata Ortega var. *leptosepala* (Nutt.) B.L. Turner, E.E. 14630, 16434, 16837.
Indigofera miniata Ortega var. *miniata* Ortega, E.E. 14881, 16276, 18908; LL 220671.
Indigofera suffruticosa Mill., E.E. 13330, 14888, 14894, 15211, 16681.
Lathyrus longipes White, E.E. 15398, 15408, 15982; J.V. 7134.
Lathyrus parvifolius S. Watson, E.E. 15397, 15410, 15410, 15456, 19578; J.V. 7133.
Lespedeza virginica (L.) Britton, LL 103958.
Leucaena greggii S. Watson, E.E. 16104, 19264; G.H. 24967; J.V. 7130; TEX 257620.
Leucaena pulverulenta Benth., E.E. 13382, 14862, 16049, 16756a, 18915; LL 257732; TEX 257733, 257737.
**Lupinus caballoanus* B.L. Turner, E.E. 14682, 15400, 15401, 15419, 15427, 15973, 16601, 19601; TEX 180565, 180567, 180567, 180569, 371344.
Lupinus muelleri Standl., J.V. 7124.
Lupinus potosinus Rose, TEX 180883.
Lupinus texensis Hook., E.E. 13326; TEX 180939, 180948, 180960.
Macroptilium gibbosifolium (Ortega) A. Delgado, G.H. 24355.
Marina scopa Barneby, TEX 272453.
Medicago lupulina L., E.E. 14871, 15458, 16045, 16418, 16467, 16636.
Medicago polymorpha L., E.E. 16085; J.V. 7126.
Medicago sativa L., E.E. 19216.
Melilotus albus Medik., E.E. 18971, 18982.
Melilotus indicus (L.) All., E.E. 16069, 16086.
Mimosa malacophylla A. Gray, E.E. 19388; G.H. 24108; TEX 230417.
Mimosa quadrivalvis L. var. *latidens* (Small) Barneby, E.E. 15216.
Mimosa texana (A. Gray) Small var. *texana* (A. Gray) Small, E.E. 15212, 16393, 16661, 19325.
Mimosa zygophylla Benth., TEX 230703.
Nissolia platycalyx S. Watson, TEX 272737.
Nissolia platycarpa Benth, TEX 272753.
Orbexilum melanocarpum (Benth.) Rydb., E.E. 15446.
Orbexilum oliganthum G. Nesom, LL 272877; TEX 272879.
Oxyrhynchus sp. TEX 272902.
Painteria elachistophylla (S. Watson) Britton & Rose, E.E. 13329, 13340, 15147.
Pediomelum rhombifolium (Torr. & A. Gray) Rydb., E.E. 16226, 16489, 16536, 18914, 18992.
Phaseolus albiflorus Freytag & Debouck, E.E. 16630, 16642, 16769, 16786, 18927, 19028.
Phaseolus glabellus Piper, TEX 273159.
Phaseolus leptostachyus Benth. var. *leptostachyus* Benth., E.E. 18881, 16657; TEX 273162.
Phaseolus maculatus Scheele ssp. *ritensis* (M.E. Jones) Freytag, E.E. 16842.
Phaseolus neglectus F.J. Hermann, J.V. 8687.
Phaseolus scabrellus Benth. ex S. Watson, E.E. 14675, 14845, 14847.
Phaseolus vulgaris L., E.E. 19187.
Pisum sativum L., E.E. 16068.
Prosopis glandulosa Torr. var. *glandulosa* Torr., E.E. 12746; G.H. 24970; TEX 96282.
Prosopis glandulosa Torr. var. *torreyana* (L.D. Benson) Johnst, E.E. 13337, 16709.
Prosopis laevigata (Humb. & Bombp. ex Willd.) M.C. Johnst, E.E. 13332.
Rhynchosia difformis (Elliott) DC., E.E. 13372.
Rhynchosia longeracemosa Mart. & Galeotti, E.E. 18892.
Rhynchosia minima (L.) DC., E.E. 14848, 14850, 16236.
Rhynchosia senna Gillis ex Hook. & Arn. var. *angustifolia* (A. Gray) Grear, G.H. 25484.
Robinia pseudo-acacia L., J.V. 7125.
Securigera varia (L.) Lassen, E.E. 14666, 16126, 16176; G.H. 24138; J.V. 7128; TEX 220080, 255415.
Senna lindheimerana Scheele, E.E. 13385, 14704, 14859, 15210, 16560, 19109, 19273; G.H. 22189.
Senna occidentalis (L.) Link, E.E. 19405.
Trifolium amabile Kunth, J.V. 7131.
Trifolium amabile Kunth var. *hemsleyi* (Lojac.) D. Heller & Zohary, E.E. 14665.
Trifolium repens L., E.E. 15975, 15986.
Vicia americana Muhl. ex Willd. ssp. *americana*, E.E. 16382.
Vicia humilis H.B.K., E.E. 15983, 16001, 16470, 16540; J.V. 7132.
Vicia pulchella Kunth, TEX 274306.
Vicia villosa Roth, E.E. 16087.
Vigna populnea Piper, E.E. 16560a, 16654, 19152, 19164.
Zapoteca media (M. Martens & Galeotti) H. Hernández, E.E. 13380.

Fagaceae
Quercus acutifolia Née var. *conspersa* (Benth.) A. DC., LL 169142.
Quercus affinis M. Martens & Galeotti, E.E. 15463, 16336, 16377.
Quercus canbyi Trel., E.E. 12719, 13334, 14705, 14890, 18894, 19132, 19170, 19211, 19472; G.H. 25924, 25939; J.V. 8704; TEX 171884.
Quercus coccolobaefolia Trel., E.E. 15416, 15432, 15445, 16375, 16482, 16535.
Quercus conspersa Benth., TEX 169142.
Quercus fusiformis Small, TEX 169498.
Quercus greggii (A. DC.) Trel., E.E. 16380, 19557; G.H. 17828; TEX 169683, 169702.
Quercus hintoniorum Nixon & C.A. Mull., E.E. 12726.
Quercus intricata Trel., G.H. 25923; J.V. 7114.
Quercus laceyi Small, E.E. 13312, 18885; G.H. 25922; TEX 169970, 235375.
Quercus laeta Liebm., E.E. 15441, 15443, 16283, 16381, 16499, 16532, 19014; G.H. 24436, 24940; J.V. 8566; TEX 241052, 241053.
Quercus laurina Bonpl., E.E. 15459.
Quercus mexicana Humb. & Bonpl., E.E. 16303, 19013.
Quercus pinnativenulosa C.H. Mull., E.E. 15417, 15435; TEX 370427.
Quercus polymorpha Schltdl. & Cham., E.E. 13371, 16212, 16213, 18943, 19311, 19321; G.H. 24166, 24983; J.V. 8703; LL 241700, 241701; TEX 235413, 235414, 235418, 241674, 241746.
Quercus pringlei Seem., TEX 241782.
Quercus rysophylla Weath., E.E. 13309, 15420, 16553; G.H. 24101; TEX 235077, 235081, 235083, 255307.
Quercus saltillensis Trel., G.H. 24934; TEX 235112.
Quercus sartorii x mexicana Liem., E.E. 16132, 19029.
Quercus sideroxyla Humb. & Bonpl., TEX 235217.
Quercus striatula Trel., E.E. 12718, 12721, 19015.
Quercus trinidadensis C.H. Muller, LL 370440, 370443.
Quercus tuberculata Liebm., E.E. 19465; TEX 235462.
Quercus virginiana Mill. var. *fusiformis* (Small) E. Murray, TEX 169498.

Flacourtiaceae
Neopringlea integrifolia (Hemsl.) S. Watson, E.E. 19349; G.H. 24975; TEX 157139, 157150.
Xylosma flexuosum Hemsl., E.E. 19462; J.V. 8686; LL 157358; TEX 157341, 157342, 157360.

Fouquieriaceae
Fouquieria splendens Engelm., E.E. 19479.

Garryaceae
Garrya glaberrima Wangerin, E.E. 15461, 16341; LL 163795; TEX 163793.
Garrya laurifolia Harte. ex Benth. var. *macrophylla* (Benth.) Dahling, E.E. 16305; TEX 163868, 163868,
Garrya ovata Benth. var. *mexicana* Dahling, E.E. 12724; J.V. 8670; TEX 154026.
Garrya wrightii Torr., E.E. 19585.

Gentianaceae

Centaurium arizonicum (A. Gray) A. Heller, TEX 251231.

Eustoma exaltatum (L.) Salisb., G.H. 17830, 18273; TEX 251338.

Geraniaceae

Erodium cicutarium (L.) L'Hér., E.E. 19559.

Geranium seemanni Peyr., E.E. 11308, 14635, 14638a, 16056, 16388, 16448, 16617, 16784, 18912, 18916, 19159; LL 154864; TEX 154862, 154873, 154876.

Pelargonium odoratissimum L'Hér., E.E. 16604, 19402.

Hydrangeaceae

Fendlera linearis Rehder, E.E. 18940.

Fendlerella lasiopetala Standl., TEX 168856.

Philadelphus calcicola S.Y. Hu., TEX 154354.

Philadelphus madrensis Hemsl., E.E. 16112, 18954; TEX 255010.

Philadelphus pringlei S.Y. Hu., TEX 154357, 154358.

Hydrophyllaceae

Nama biflorum Choisy, G.H. 24119, 24420, 25471; LL 248069, 248070, 248072; TEX 248066, 248068, 248071, 248074, 248078, 248085, 248091, 248093, 248094, 248096, 248098.

**Nama hintoniorum* G.L.Nesom, TEX 248263.

Nama hispidum A. Gray, LL 248354; TEX 248346, 248347, 248352.

Nama hispidum A. Gray var. *spathulatum* C.L. Hitchc., E.E. 16063.

Nama palmeri A. Gray, E.E. 18944; G.H. 24349,; J.V. 7108.

Nama stenophyllum A. Gray ex Hemsl., TEX 248604.

Nama undulatum Kunth, E.E. 13360; G.H. 24215.

Phacelia congesta Hook., E.E. 16324; LL 248687.

Phacelia rupestris Greene, LL 248995; TEX 248973, 248998.

Juglandaceae

Carya illinoeinsis (Wangenh.) K. Koch, E.E. 16361.

Carya myristicaeformis Nutt., E.E. 16182; J.V. 8672; TEX 171327, 171331.

Carya ovata Britton & Stern et Pogg. var. *mexicana* (Engelm. ex Hemsl.) W.E. Manning, E.E. 16531; J.V. 8565; TEX 213882.

Carya ovata Britton & Stern et Pogg. var. *ovata*, TEX 171337, 171340, 171341.

Carya palmeri W.E. Manning, J.V. 8592; LL 171364; TEX 171366, 171368, 171371, 245904.

Juglans major (Torr.) A. Heller, E.E. 16471.

Juglans mollis Engelm., E.E. 19024; G.H. 24963; TEX 171435, 171436, 171438.

Krameriaceae

Krameria cytisoides Cav., LL 215985.

Lamiaceae

Agastache palmeri (B.L. Rob.) var. *leonensis* R.W. Sanders, TEX 164118.

Hedeoma costata A. Gray var. *costata*, E.E. 15958, 16055, 16284, 16462, 16477; G.H. 24134, 24423; J.V. 8571; LL 164771, 164783; TEX 164768, 164769, 164770, 164772, 164773, 164785.

Hedeoma costata A. Gray var. *pulchella* (Greene) R.S. Irving, J.V. 7102.

Hedeoma drummondii Benth., E.E. 16217, 19615; LL 164366; TEX 164353, 164364, 164821.

Hedeoma irvingii B.L. Turner, TEX 164833.

Hedeoma nana (Torr.) Briq. var. *nana*, E.E. 15955.

Hedeoma palmeri Hemsl. var. *santiagoana* B.L. Turner, E.E. 16500, 16526, 16755; TEX 164868, 164872.

Hedeoma plicata Torr., E.E. 11322; TEX 164879.

Hyptis mutabilis (A.T. Richardon) Briq., TEX 164685.

Leonotis nepetaefolia R. Br.., TEX 165120.

Majorana hortensis Moench, E.E. 16608.

Marrubium vulgare L., E.E. 16016, 16094, 16366, 16616.

Mentha piperita L., E.E. 16092.

Mentha rotundifolia (L.) Huds., E.E. 16073, 16160.

Mentha spicata L., E.E. 16153.

Micromeria brownei (Sw.) Benth., TEX 165311.

Monarda citriodora Cerv. ex Lag. var. *citriodora*, E.E. 16433, 16152.

Monarda pringlei Fern., G.H. 24110, 24336.

Poliomintha longiflora A. Gray, TEX 165506.

Physostegia correllii (Lundell) Shinners, TEX 165439.

Prunella vulgaris L., E.E. 14636, 15989, 16345, 16466; LL 165533; TEX 165543, 165569.

Rosmarinus officinalis L., E.E. 16359.

Salvia ballotiflora Benth., TEX 244401, 244416.

Salvia caudata Epling, TEX 249467, 249471.

Salvia coahuilensis Fernald, E.E. 18906, 19161, TEX 234613, 234615.

Salvia coccinea Murray, E.E. 13301, 14649, 16059, 19084, TEX 234203, 234215, 234220, 234227.

Salvia compsostachys Epling, TEX 234473, 234477.

Salvia coulteri Epl., E.E. 18918; G.H. 25942.

Salvia forreri Greene, LL 244843.

Salvia greggii A. Gray, E.E. 16603, 19162; G.H. 25933; TEX 234758, 249852, 249855.

Salvia hispanica L., E.E. 16742, 18929.

Salvia involucrata Cav., TEX 229236.

Salvia jaimehintoniana Ramamoorthy ex B.L. Turner, TEX 234960.

Salvia reflexa Hornem., LL 234096.

Salvia regla Cav., LL 229007; TEX 229001, 229004.

Salvia roemeriana Scheele, G.H. 24366, 25941; TEX 223924, 223926, 223968, 223975, 229528, 229529.

Salvia serotina L., LL 234017; TEX 234016.

Salvia sharpii Epling & Mathias, TEX 249774.

Salvia texana (Scheele) Torr., TEX 229539.

Salvia urolepis Fernald, G.H. 25904, 25943, 24954; LL 249386; TEX 249382.

Scutellaria drummondii Benth., E.E. 16261.

**Scutellaria monterreyana* B.L. Turner, E.E. 14831; G.H. 24123, 24220, 24419, 25931; LL 165792; TEX 165780, 165784, 165786, 165790, 165791.

Scutellaria muzquiziana B.L. Turner, E.E. 14658.

Scutellaria potosina Brandegee var. *novoleonensis* B.L. Turner, G.H. 24356, 25935; TEX 165836.

Scutellaria potosina Brandegee var. *potosina*, E.E. 13389.

Scutellaria seleriana Loes, TEX 165882, 165884, 165886.

Scutellaria suffrutescens S. Watson, E.E. 16279, 16340; LL 165930; TEX 165916, 165917, 165923, 165924, 165925, 165926, 165928.

Stachys agraria Cham. & Schltdl., G.H. 24111, 24345; TEX 165971.

Stachys bigelovii A. Gray, G.H. 25913.

Stachys crenata Phil., E.E. 16294, 15966.

Stachys grahami Benth., G.H. 24399.

**Stachys vulnerabilis* Rzed. & Calderón, TEX 250846.

Teucrium canadense L., G.H. 17826.

Teucrium cubense Jacq. ssp. *cubense*, E.E. 16071, 16797, 19398; G.H. 24130, 24434, 25899; TEX 250890, 250891, 250927.

Teucrium cubense Jacq. var. *laevigatum* (Vahl) E.M. McClint. & Epling, TEX 250969.

Lauraceae

Litsea glauscecens Kunth, E.E. 19441.

Litsea muelleri Rehder, TEX 146537.

Litsea parvifolia Mez, E.E. 12737, 16077, 16374, 16621; J.V. 8663.

Litsea pringlei Bartlett, E.E. 16277.

Persea americana Mill., TEX 146963.

Persea americana Mill. var. *drymifolia* (Schltdl. & Cham.) S.F. Blake, TEX 147001.

Persea longipes Meisn., E.E. 16789.

Lentibulariaceae

Pinguicula cyclosecta Casper, TEX 105638.

Linaceae

Linum lasiocarpum Rose, E.E. 16139, 16368; G.H. 24232, 24409; TEX 254559, 254567.

**Linum modestum* C.M. Rogers, TEX 254656.

Linum nelsoni Rose, E.E. 14708; TEX 254667, 254668, 254671.

Linum schiedeanum Schltdl. & Cham., G.H. 25946; TEX 254817, 254895.

Loasaceae

Cevallia sinuata Lag., E.E. 16687; TEX 181015.

Eucnide bartonioides Zucc., TEX 181065.

Eucnide lobata (Hook.) A. Gray, E.E. 16694; G.H. 17821, 22157, 24418; J.V. 7120, TEX 181122, 181150, 181160.

Eucnide xylinea C.H. Müll., G.H. 24145, 24365; TEX 181199.

Mentzelia hispida Willd., G.H. 25901; TEX 181322, 212118.

Mentzelia incisa Urb. & Gilg, E.E. 14856.

Mentzelia lindheimeri Urb. & Gilg, TEX 188582.

Loganiaceae

Buddleja cordata Kunth var. *tomentella* (Standl.) E.M. Norman, TEX 265606.

Cynoctonum mitreola (L.) Britton, E.E. 16567.

Lythraceae

Cuphea aequipetala Cav., E.E. 16334, 16504, 16542.

Cuphea cyanea DC., LL 271750,; TEX 271739, 271740, 271754, 271769.

Cuphea lanceolata Aiton, TEX 271980.

Heimia salicifolia Link & Otto., E.E. 16103, 16710, 16766, 18877, 19387; LL 270422, 270425; TEX 270379, 270465, 270469, 270471.

Lythrum californicum Torr. & A. Gray, E.E. 14638, 16145, 16602.

Magnoliaceae

Magnolia dealbata Zucc., E.E. 15434.

Malpighiaceae

Callaeum septentrionale (Juss) D.M. Johnson, G.H. 22187; LL 275168; TEX 275186, 275192, 275193, 275214, 275215.

Malpighia glabra L., TEX 275540.

Mascagnia lilacina (S. Watson) Nied., E.E. 18962; G.H. 25954; TEX 275598, 275599.

Mascagnia macroptera (DC.) Nied., E.E. 16201, 16761, 16791.

Malvaceae

Abutilon fruticosum Guill. & Perr., TEX 140352.

Abutilon hypoleucum A. Gray, E.E. 13297, 18938, 19314, 19360; J.V. 8573; LL 140457, 140457; TEX 140430, 140431, 140435, 140446, 140470.

Allowissadula holosericea (Scheele) D.M. Bates, J.V. 8694.

Anoda cristata Schltdl., E.E. 18985; TEX 140919.

Anoda leonensis Fryxell, TEX 74054, 74055.

Batesimalva violacea (Rose) Fryxell, E.E. 13335, 18928, 18938a, 19158; J.V. 8572, 8693; TEX 74251.

Callirhoe involucrata (Torr. & A. Gray) A. Gray var. *tenuissima* Palmer ex Baker, TEX 74320.

Herissantia crispa (L.) Brizicky, TEX 74603, 74681.

Hibiscus acicularis Standl., E.E. 18889.

Hibiscus coulteri Harv. ex A. Gray, E.E. 16172.

Hibiscus denudatus Benth., E.E. 16651.

Hibiscus martianus Zucc., TEX 74778.

Malva parviflora L., E.E. 16013.

Malvastrum americanum (L.) Torr., TEX 73359.

Malvastrum coromandelianum (L.) Garcke, E.E. 16715; TEX 73424, 73446.

Melochia pyramidata L., E.E. 16508; G.H. 24223; TEX 76299.

Pavonia lasiopetala Scheele, G.H. 24337; TEX 73780, 73786.

Sida abutilifolia Mill., E.E. 16668, 16718.

Sida elliottii Torr. & A. Gray var. *parvifolia* Champ., TEX 72401, 72406.

Sida rhombifolia L., E.E. 13361, 16222, 16730, 18949; G.H. 24221; TEX 72546, 72551, 72611, 72612.

Sida spinosa L., G.H. 24222; TEX 72674.

Sphaeralcea angustifolia (Cav.) G. Don, G.H. 24362.

Sphaeralcea endlichii Ulbr., LL 72887; TEX 222827.

Sphaeralcea hastulata A. Gray, TEX 72922.

Wissadula amplissima (L.) R.E. Fries, TEX 77130, 77142.

Meliaceae

Melia azedarach L., E.E. 19614; TEX 274660.

Menispermaceae

Cocculus carolinus (L.) DC., J.V. 8700; LL 247122; TEX 247123.

Moraceae

Ficus carica L., E.E. 16164.

Morus alba L., E.E. 16159.

Morus celtidifolia Kunth, E.E. 13381; J.V. 7104; LL 216393.

Myrtaceae

Psidium guajava L., G.H. 24167.

Nyctaginaceae

Acleisanthes longiflora A. Gray, E.E. 16674.

Acleisanthes obtusa (Choisy) Standl., TEX 191822.

Allionia choisyi Standl., E.E. 16700.

Allionia incarnata L. var. *incarnata* L., TEX 95072, 95078.

Boerhavia coccinea Mill., E.E. 16219, 18933; G.H. 24988.

Cyphomeris crassifolia (Standl.) Standl., G.H. 25912; TEX 95239.

Mirabilis albida Heimerl, E.E. 16401, G.H. 25447.

Mirabilis glabrifolia (Ortega) I.M. Johnst., G.H. 24403, 25949; LL 95371; TEX 95365.

Mirabilis jalapa L., E.E. 16199, 16614, 16736.

Mirabilis longiflora L. var. *wrightiana* (A. Gray ex Britton & Kearney) Kearney & Peebles, TEX 95580, 95581.

**Mirabilis nesomii* B.L. Turner, G.H. 25567.

Mirabilis oxybaphoides (A. Gray) A. Gray in Emory, G.H. 25572.

Mirabilis polonii Le Duc., TEX 253429.

Nyctaginia capitata Choisy, LL 95721.

Oleaceae

Forestiera reticulata Torr., LL 156714, 156715, 156716; TEX 156707.

Fraxinus cuspidata Torr., E.E. 16003, 16424, 19480; G.H. 24370, 24964, 24977; LL 156807; TEX 245903.

Fraxinus greggii A. Gray, E.E. 19427; TEX 156877.

Menodora longiflora A. Gray, TEX 265397.

Osmanthus americana (L.) Benth. & Hook. f. ex A. Gray, J.V. 7123.

Onagraceae

Calylophus hartwegii (Benth.) P.H. Raven var. *hartwegii*, G.H. 25459.

Gaura calcicola P.H. Raven & D.P. Greg., E.E. 16419, 16835, 18981; TEX 160643, 160729.

Gaura coccinea Puesh, E.E. 14657, G.H. 24395, 25916.

Lopezia nuevo-leonis Plitmann, P.H. Raven & Breedlove, E.E. 18947.

Lopezia racemosa Cav., J.V. 8594; TEX 160988, 160991.

Oenothera jamesii (Torr.) A. Gray, E.E. 16649, 16836; LL 161349.

Oenothera kunthiana (Spach) Munz, E.E. 13310, 16088; TEX 161380, 161386.

Oenothera rosea L'Hér, ex Aiton, E.E. 15962, 16295, 16442, 16461; LL 161521, 161527; TEX 161528, 161532, 161535, 161542, 257732.

Oenothera speciosa Nutt., E.E. 16628; G.H. 24361.

Oenothera tetraptera Cav., E.E. 16408, 16422; LL 161647; TEX 161660.

Orobanchaceae

Castilleja integrifolia L. var. integrifolia L. F., LL 179487; TEX 179491, 179480.

Castilleja lanata A. Gray in Emory, G.H. 25953.

Castilleja scorzonerifolia Kunth, E.E. 16021; TEX 179827.

Castilleja tenuiflora Benth. var. *xylorrhiza* (Eastw.) G.L. Nesom, G.H. 24233, 24472; TEX 87046, 87050, 87058, 87060.
Conopholis alpina Liebm. var. *mexicana* (A. Gray ex S. Watson) R.R. Haynes, E.E. 13377; TEX 105180, 105215.
Pedicularis canadensis L., TEX 106796.
**Seymeria deflexa* Eastw., E.E. 19260; G.H. 25930; J.V. 8677; TEX 104066.
Seymeria virgata (Kunth) Benth., LL 104143, TEX 104133, 104134.

Oxalidaceae
Oxalis berlandieri Torr., E.E. 14709.
Oxalis corniculata L. var. *pilosa* (Nutt.) B.L. Turner, E.E. 14670, 16018, 16332, 16412, 18973; TEX 254119, 254133, 254135, 254138.
Oxalis drummondii A. Gray, E.E. 13317, 15972, 15979, 18890, 19239, 19395; LL 254274; TEX 254270, 254288, 254291.
Oxalis latifolia Kunth, E.E. 16333, 16443, 19425; TEX 190385.

Papaveraceae
Argemone aenea G.B. Ownbey, E.E. 16415.
Argemone albiflora Hornem., G.H. 24974.
Argemone echinata G.B. Ownbey, G.H. 17822.
Argemone grandiflora Sweet, TEX 147323.
Argemone mexicana L. ssp. *mexicana*, TEX 147341, 147344, 147350.
Bocconia frutescens L., E.E. 16758; TEX 147497, 147504, 147509, 147511.
Corydalis pseudomicrantha Fedde., J.V. 7136.
Hunnemannia fumariifolia Sweet, E.E. 12740, 16406, 18991; G.H. 24140; TEX 147620, 147622, 147632, 149624.

Passifloraceae
Passiflora affinis Engelm., TEX 157609, 157612.
Passiflora foetida L., TEX 147323.
Passiflora suberosa L., J.V. 8692.

Pedaliaceae
Proboscidea louisianica (Mill.) Thell. var. *fragrans* (Lindl.) Bretting, LL 105156.

Phrymaceae
Mimulus glabratus A. Gray, E.E. 16476.

Phytolaccaceae
Phytolacca icosandra L., E.E. 16268; G.H. 24115, 24408.
Rivina humilis L., E.E. 18966, 19686; G.H. 24174; LL 258068; TEX 258060, 258063, 258067, 258083, 258089.

Picramniaceae
Picramnia polyantha (Benth.) Planch., E.E. 19634; LL 189458; TEX 200013.

Piperaceae
Peperomia berlandieri Miq., TEX 111917, 111918.
Peperomia blanda (Jacq.) Kunth, LL 111966; TEX 111963, 111967, 111968, 111970,
111972, 111973.
Peperomia campylotropa A.W. Hill, TEX 111992.
Peperomia quadrifolia (L.) Kunth., E.E. 16328, 16516; TEX 255034.
Piper auritum Kunth, G.H. 17828b.

Plantaginaceae
Bacopa monnieri (L.) Pennell, E.E. 16246, 19546.
Maurandya barclaiana Lindl., E.E. 14866; G.H. 24490; TEX 106449.
Mecardonia procumbens (Mill.) Small, LL 106566.
Penstemon barbatus (Cav.) Roth, G.H. 24396; TEX 106995, 106996, 107001, 107026.
Penstemon campanulatus (Cav.) Willd; LL 107099.
**Penstemon galloensis* G.L. Nesom, TEX 107192.
Penstemon lanceolatus Benth., TEX 107398.
Plantago australis Lam., E.E. 14639, 14668, 16110, 16291, 16311.
Plantago australis Lam., ssp. *hirtella* (Kunth) Zahn, TEX 89528.
Plantago hookeriana Fisch & C.A. Mey, TEX 89623, 89625, 89626.
Plantago lanceolata L., E.E. 14681, 16111, 18879, 18886, 19280.
Plantago major L., E.E. 16190, 18882.
Plantago rhodosperma Decne., TEX 89734.

Platanaceae
Platanus mexicana Moric. var. *mexicana*, TEX 191711.
Platanus occidentalis L. var. *glabrata* (Fern.) Sarg., G.H. 22185.
Platanus rzedowskii Nixon & J.M. Poole, E.E. 16577; TEX 150225, 150264, 150261, 150262, 150265, 191711.

Plumbaginaceae
Plumbago scandens L., TEX 228400, 228430, 228437.

Polemoniaceae
Cobaea pringlei (House) Standl., E.E. 18948, 19153; TEX 217928, 217929, 217930, 217931, 217932, 217933, 217934, 217935, 217936, 217942, 217943, 29156.
Gilia acerosa (A. Gray) Britton, G.H. 25905.
Gilia incisa Benth., G.H. 24173, 24422; TEX 192470, 192472, 192595.
Gilia rigidula Benth. var. *rigidula*, E.E. 16061.
Gilia stewartii I.M. Johnst., E.E. 14623, 14698, 14843.
Ipomopsis aggregata (Pursh) V.E. Grant ssp. *formosissima* (Greene) Wherry, G.H. 25581.
Loeselia coerulea (Cav.) G. Don, E.E. 16399, 19213, 19275.
Polemonium pauciflorum S. Watson, TEX 213204.

Polygalaceae
Polygala alba Nutt., G.H. 24433.
Polygala glandulosa Kunth, TEX 222114.
Polygala lindheimeri A. Gray var. *eucosma* (S.F. Blake) T. Wendt, G.H. 25457.
Polygala ovatifolia A. Gray, TEX 187958, 187962.
Polygala scoparioides Chodat, LL 200473.
Polygala semialata S. Watson, TEX 187884.
Polygala viridis S. Watson, J.V. 1254.

Polygonaceae
Eriogonum greggii Torr. & A. Gray, G.H. 22156.
Eriogonum jamesii Benth. var. *undulatum* (Benth.) S. Stokes ex M.E. Jones, E.E. 12728; TEX 109968.
Polygonum aviculare L., E.E. 16100.
Polygonum hydropiperoides Michx., TEX 172304.
Polygonum lapathifolium L., E.E. 16118, 16643, 16745.
Rumex mexicanus Meissner, E.E. 16097, 16157, 16242, 16502, 18972.
Rumex obtusifolius L., TEX 172569.
Rumex pulcher L. var. *eupulcher* Rech., E.E. 14661.

Portulacaceae
Portulaca oleracea L., E.E. 16699.
Portulaca pilosa L., G.H. 24432.
Talinopsis frutescens A. Gray, TEX 253632.
Talinum aurantiacum Engelm., G.H. 24357.
Talinum paniculatum (Jacq.) Gaetern., E.E. 16793.

Primulaceae
Anagallis arvensis L., E.E. 15951; J.V. 7111; TEX 228180, 228204.
Samolus ebracteatus Kunth var. *cuneatus* (Small) Henr., E.E. 13349; TEX 228277, 228278.
Samolus parviflorus Raf., TEX 228333, 228350.

Ranunculaceae
Aquilegia chrysantha A. Gray, E.E. 19602.
Aquilegia longissima A. Gray ex S. Watson, TEX 239917, 239942, 239943, 239944.
Clematis drummondii Torr. & A. Gray, E.E. 16441, 19679; G.H. 25469; LL 240047; TEX 240049, 240057, 240059.
Clematis pitcheri Torr. & A. Gray, E.E. 16006, 19509; J.V. 8584.

Delphinium madrense S. Watson, E.E. 13356; G.H. 24217; TEX 240311, 240313, 240319, 240323.

Ranunculus peruvianus Pers., E.E. 11808, 16308; LL 240559; TEX 240533, 240535.

Ranunculus petiolaris Kunth ex DC., TEX 240613.

Ranunculus sierrae-orientalis (L.D. Benson) G.L. Nesom, E.E. 13307, 16070; TEX 240612, 240614, 240615.

Thalictrum grandifolium S. Watson, TEX 240765, 240770, 240772, 240773.

Resedaceae

Oligomeris linifolia (Vahl) J.F. Macbr, TEX 149993.

Rhamaceae

Ceanothus buxifolius Willd. ex Kunth, E.E. 19526; LL 264796; TEX 264788.

Ceanothus coeruleus Lag., E.E. 12722; G.H. 25950; TEX 264853, 264883, 264890, 264898, 264957, 264980.

Ceanothus fendleri A. Gray, E.E. 18995.

Colubrina greggii S. Watson var. *greggii*, E.E. 18911, 16048, 19319; G.H. 24097, 24125, 24368; LL 265218; TEX 262004, 262032, 262040, 262044, 265068, 265220, 265222, 265223.

Condalia hookeri M.C. Johnst, TEX 263673.

Condalia viridis I.M. Johnst., TEX 263733.

Karwinskia humboltiana (Roem. & Schult.) Zucc., E.E. 13351, 13368, 16251, 16435, 16701, 19118, 19141; LL 77516; TEX 77536, 77417.

Rhamnus betulifolia Greene, E.E. 16348; J.V. 8570, 8701; LL 77810; TEX 77812.

Rhamnus serrata Schult., TEX 84588.

Rosaceae

Cercocarpus fothergilloides Kunth, E.E. 12725, 19249; G.H. 24164, 24165.

Cercocarpus macrophyllus C.K. Schneid., TEX 150381.

Cowania plicata D. Don, E.E. 12733, 16082, 18888.

Crataegus crus-galli L., J.V. 7103.

Crataegus rosei Egg. var. *rosei*, J.V. 8598; LL 150801; TEX 150801, 150803, 150808.

Crataegus tracyi Ashe var. *madrensis* J.B. Phipps, E.E. 16054, 16480.

Duchesnea indica (Andr.) Focke, G.H. 24136; TEX 150887.

Fragaria californica Cham. & Schltdl., TEX 256033.

Fragaria virginiana Mill. var. *ovalis* (Lehm.) R.J. Davis, LL 150947.

Holodiscus discolor (Pursh) Maxim., TEX 151028.

Lindleya mespiloides Kunth, E.E. 12732; G.H. 24144.

Malacomeles denticulata Engl., LL 151223; TEX 151196.

Malacomeles paniculata (Rehder) J.B.Phipps, TEX 151277, 151278.

Physocarpus opulifolius (L.) Maxim. *var. intermedius* (Rydb.) B.L.Rob., TEX 151335.

Prunus domestica L., E.E. 16165.

Prunus mexicana S. Watson, E.E. 16615, 19435; LL 189366; TEX 151538.

Prunus serotina Ehrh. ssp. *serotina*, TEX 151651, 151652.

Prunus serotina Ehrh. ssp. *virens* (Wooton & Standl.) McVaugh, E.E. 16515; TEX 151728.

Rosa carolina L., TEX 151939.

Rosa serrulata Crép., E.E. 16133, 16599, 19392; J.V. 8561; TEX 151912, 151913.

Rubus flagellaris Lefev. & P.J. Muell., G.H. 24135; TEX 152046.

Rubus humistratus Steud., E.E. 16050.

Rubus trivialis S. Watson, E.E. 16491, TEX 152125, 255413.

Vauquelinia corymbosa Humb. & Bonpl., E.E. 19285.

Vauquelinia corymbosa Humb. & Bonpl. var. *saltilloensis* Hess. & Henr., E.E. 12739, 12747, 16282, 16355; G.H. 25918; TEX 152258, 255011.

Rubiaceae

Borreria laevis (Lam.) Griseb, LL 89877; TEX 89929.

Bouvardia ternifolia Standl., E.E. 16256, 18884, 18924, LL 178384; TEX 178369, 178388, 178389, 178390, 178404, 178407, 178409, 178419, 178420.

Cephalanthus occidentalis L., E.E. 16572; TEX 178680.

Chiococca alba Hitchc., E.E. 19347; J.V. 8674.

Crusea diversifolia (Kunth) W.R. Anderson, G.H. 25580.

Galium microphyllum A. Gray, TEX 42551, 42552.

Galium oresbium Greenm., J.V. 7122.

**Galium pringlei* Greenm., LL 42586, 42590; TEX 42587, 42588.

Galium rzedowskii Dempster, TEX 42609.

Galium uncinulatum DC., E.E. 14679; G.H. 24128, 24410; J.V. 7121; LL 42724, 42727, 42728; TEX 42687, 42700, 42711, 42712, 42714, 42732.

Hedyotis intricata Fosberg, TEX 45429.

Hedyotis nigricans (Lam.) Fosberg var. *nigricans*g, E.E. 16147, 16327, 16402, 18988; G.H. 24351, 24373, 25940, 25948; TEX 45319, 45430.

Hedyotis nigricans (Lam.) Fosberg var. *gypsophila* B.L. Turner, TEX 45336.

Hedyotis palmeri (A. Gray) W.H. Lewis, G.H. 25449.

Houstonia acerosa (A. Gray) Benth. & Hook.f. ssp. *acerosa*, TEX 45243.

Oldenlandia ovata S. Watson, LL 45698; TEX 45696, 45697.

Randia laetevirens Standl., E.E. 16170, 16248; LL 47400; TEX 47375, 47380, 47382, 47387, 47402.

Randia pringlei A. Gray, J.V. 7113.

Rutaceae

Amyris madrensis S. Watson, E.E. 19430; LL 235830.

Amyris marshii Standl., LL 235818, TEX 235812.

Casimiroa greggii (S. Watson) F. Chiang, E.E. 16211, 16216; LL 183738; TEX 183719, 183724, 183725, 183726, 183729, 183730.

Casimiroa pringlei S. Watson, E.E. 17346.

Decatropis bicolor (Zucc.) Radlk., E.E. 14879, 19324; G.H. 24346; J.V. 8698; LL 183667; TEX 183858, 183866, 183874, 183878, 183884, 183941.

Esenbeckia berlandieri Baill., E.E. 16259; TEX 189590, 259366.

Helietta parvifolia (A. Gray ex. Hemsl.) Benth., E.E. 16253, 16713, 19300; G.H. 24960, 24966; TEX 189520, 189637, 189640.

Ptelea trifoliata L., E.E. 19322, 19493; LL 187450; TEX 187427.

Ruta graveolens L., E.E. 16015, 16075, 16609.

Thamnosma texana (A. Gray) Torr., E.E. 19490.

Zanthoxylum fagara (L.) Sarg., TEX 188705, 259433, 259456.

Sabiaceae

Meliosma alba (Schltdl.) Walp., LL 264625; TEX 264626.

Salicaceae

Populus mexicana Wesm. ex DC., E.E. 19714; TEX 244201, 244209.

Populus tremuloides Michx., J.V. 7109; TEX 244224.

Salix nigra L., TEX 171172, 171174, 171175.

Sapindaceae

Acer negundo L., E.E. 15998; TEX 231643, 231644, 231645.

Cardiospermum halicacabum L., J.V. 8685, TEX 231775.

Dodonaea viscosa Jacq., E.E. 13304, 16371, 16731, 19329; TEX 264011, 264047.

Koerleuteria paniculata Laxm., J.V. 8675.

Sapindus saponaria L., E.E. 16185; TEX 264229, 264257.

Serjania brachycarpa A. Gray ex Radlk., E.E. 19354; TEX 264301.

Serjania incisa Torr., E.E. 16229.

Ungnadia speciosa Endl., E.E. 16735, 16790, TEX 264548, 264567.

Urvillea ulmacea Kunth, TEX 264579, 264616.

Sapotaceae

Syderoxylon lanuginosum (Michx.) Pers., E.E. 19470; G.H. 25911; LL 156065; TEX 156067.

Saxifragaceae

Heuchera mexicana W. Schaffn., E.E. 16108.

Heuchera rubescens Torr., TEX 168904.

Scrophulariaceae

Buddleja cordata Kunth ssp. *cordata*, LL 265586; TEX 265584, 265590, 265594.

Buddleja cordata Kunth ssp. *tometella* (Standl.) E.M. Norman, E.E. 16754; G.H. 24392, 24985; J.V. 8669; TEX 265606.

Buddleja marrubiifolia Benth., TEX 265757.

Cymbalaria muralis Gaertn., B. Mey. & Schreb., E.E. 16009.

Leucophyllum frutescens (Berl.) I.M. Johnston, TEX 106029.

Leucophyllum langmaniae Flyr, G.H. 24952, 25903, 25952; LL 106156; TEX 106157.

Solanaceae

Bouchetia erecta Dunal, G.H. 24400, 25568; TEX 226073, 226080.

Capsicum annuum L. var. *minus* (Dunal) C.B. Heiser & Pickersgill, E.E. 14870, 19429; TEX 226173, 226198.

Capsicum baccatum L., TEX 226211.

Capsicum ciliatum (Kunth) Kuntze, LL 226223; TEX; 226219, 226221, 226234.

Cestrum anagyris Dunal, E.E. 13302.

Cestrum oblongifolium Schltdl., TEX 226383.

Datura stramonium L., E.E. 16776.

Hunzikeria texana (Torr.) D'Arcy, TEX 226796, 226800, 226811, 226801.

Jaltomata procumbens (Cav.) J.L. Gentry, TEX 226906.

Lycium berlandieri Dunal, E.E. 19483.

Nicotiana glauca Graham, E.E. 19272; TEX 227589.

Nicotiana nudicaulis S. Watson., LL 227608.

Nicotiana plumbaginifolia Viv., TEX 227618.

Nicotiana trigonophylla Dunal, E.E. 13354, 18989.

Petunia parviflora Juss, E.E. 16692.

Physalis hederifolia A. Gray, G.H. 25981.

Physalis philadelphica Lam., TEX 219178.

Physalis pubescens L., TEX 219241, 219242.

Physalis sordida Fernald, J.V. 7100.

Physalis viscosa L., E.E. 16747; G.H. 24350; TEX 227800, 227815, 227826, 227834, 227835.

Solanum americanum Mill., E.E. 16794.

Solanum douglasii Dunal, TEX 219821, 219822, 219825, 219828, 219831.

Solanum elaeagnifolium Cav., E.E. 19343.

Solanum erianthum D. Don, E.E. 16234, 19406; G.H. 24226; TEX 219985, 219992, 219993.

Solanum rostratum Dunal, E.E. 16675.

Witheringia mexicana (B.L. Rob.) Hunz., E.E. 13306; G.H. 24227; J.V. 8586, 8681; TEX 107875.

Staphyleaceae

Staphylea pringlei S. Watson, E.E 15682; LL 231515, TEX 231511.

Styracaceae

Styrax platanifolius Engeml. ex Torr. var. *mollis* P.W. Fritsch, TEX 156448.

Tiliaceae

Tilia americana L. var. *caroliniana* (Mill.) Castigl., E.E. 11811; TEX 86821, 86828; 245905.

Turneraceae

Turnera diffusa Willd., TEX 157601.

Ulmaceae

Ulmus crassifolia Nutt., E.E. 16005, 16376.

Ulmus serotina Sarg., TEX 216867, 216867.

Urticaceae

Boehmeria cylindrica (L.) Sw., E.E. 16568; TEX 112389.

Parietaria decoris N.G. Mill., TEX 112491.

Parietaria pensylvanica Muhl. ex Willd. var. *obtusa* (Rydb. ex Small) Shinners, TEX 112510.

Pilea microphylla (L.) Liebm., LL 112650, TEX 112625, 112626, 112641, 112652, 112654.

Urtica chamaedryoides Pursh, E.E. 13390.

Urtica spirealis Blume, TEX 112933.

Valerianaceae

Valeriana clematitis Kunth, E.E. 16326, 16633.

Valeriana scandens L., TEX 78689.

Valeriana subincisa Benth., LL 78794, TEX 78793, 78794, 78796, 78797.

Verbenaceae

Aloysia gratissima (Gillis & Hook.) Tronc., LL 99090; TEX 99081.

Aloysia macrostachya (Torr.) Moldenke, E.E. 19643; TEX 99141, 99173.

Glandularia bipinnatifida (Nutt.) Nutt., E.E. 16011; J.V. 7115.

Glandularia elegans (Kunth) Umber, E.E. 11296, 13323, 15957, 1596314832; G.H. 24402.

Glandularia polyantha Umber, G.H. 24132; TEX 98259, 98262, 98270, 98272, 98279, 98282, 100000.

Glandularia quadrangulata (A. Heller) Umber var. *verecunda* (A. Heller) Umber, LL 98321, 98322, 98325; TEX 98305, 98319, 98327.

Lantana achyranthifolia Desf., J.V. 8695; LL 98451; TEX 98441, 98445, 98446, 98448, 98449, 98465.

Lantana camara L., E.E. 14885, 16708, 19088, 19124; G.H. 24099; J.V. 8696; TEX 98557.

Lantana canescens Kunth, TEX 98679, 98688, 98699.

Lantana hirsuta M. Martens & Galeotti, TEX 98767.

Lantana hirsuta x camara, TEX 98779.

Lantana macropoda Torr., E.E. 16218, 16250; TEX 98983, 100020.

Lantana velutina M. Martens & Galeotti, E.E. 16703; TEX 100195.

Lippia graveolens Kunth, TEX 100522.

Phyla fruticosa (Mill.) K. Kenn. & Rueda, TEX 100724.

Phyla incisa Small, E.E. 14855, 16186, 16673.

Phyla nodiflora (L.) Greene, G.H. 17833.

Phyla strigulosa (M. Martens & Galeotti) Moldenke, G.H. 22188, 24113, 24414.

Priva mexicana Pers., J.V. 8589; TEX 101018, 101021, 101026, 101027.

Verbena brasiliensis Vell., G.H. 24171, 24343.

Verbena canescens Kunth., E.E. 14622; G.H. 24363; TEX 101289, 101321, 101327.

Verbena carolina L., LL 101396, 101397; TEX 101394.

Verbena cloverae Moldenke, TEX 101495.

Verbena litoralis Kunth, E.E. 16047, 16095.

Verbena menthaefolia Benth., E.E. 18987.

Verbena neomexicana (A. Gray) Small, E.E. 16420; TEX 200901.

Verbena officinalis L., TEX 200276.

Verbena officinalis L. ssp. halei (Small) S.C. Barber, G.H. 24216, 24412; TEX 101539.

Verbena runyonii Moldenke, TEX 200275.

Veronicaceae

Veronica persica Poir., E.E. 13355, 15970, 16023, 19023.

Violaceae

Viola nuevo-leonensis Becker, TEX 159757, 159759.

Viscaceae

Arceuthobium vaginatum (Humb. & Bonpl. ex Willd.) C. Presl., E.E. 16492; J.V. 7112.

Phoradendron villosum (Nutt.) Nutt., E.E. 16799.

Vitaceae

Parthenocissus quinquefolia (L.) Planch., E.E. 16775, 19711; J.V. 8567; LL 263136; TEX 263114, 263138, 263139, 263140.

Vitis berlandieri Planch., E.E. 16364, 16533; J.V. 8664.

Vitis cinerea Engelm. ex. Millardet, E.E. 16845; G.H. 24141; J.V. 7119; LL 263221; TEX 263204, 263209, 263216, 263217, 263220.

Zygophyllaceae

Guaiacum angustifolium Engelm., E.E. 16711.

Kallstroemia parviflora Norton, E.E. 16702; G.H. 25461: TEX 259292.

Larrea tridentata (Sessé & Moc. ex DC.) Coville, E.E. 19632a.

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BOOK REVIEW

Daniel Chamovitz. 2013 (first paperback edition). **What A Plant Knows: A Field Guide to the Senses.** (ISBN-13: 978-0-374-53388-5, pbk.). Scientific American / Farrar, Straus and Giroux, 18 West 18th Street, New York, New York 10011 U.S.A. (**Orders:** us.macmillan.com). $14.00, 192 pp., 5 ⅜" × 8 ¼".

In *What A Plant Knows*, Daniel Chamovitz does an exceptional job at presenting a brief introduction regarding how plants experience the world through sensory perception; that is to say, what does a plant feel, hear, smell, or even know? Attempting to enlighten the popular reader who may lack a degree in botany but simply wishes to learn how or if plants are capable of gaining and interpreting knowledge through sensory perception, Chamovitz does well when explaining these biological processes unique to plants as he abstains from isolating the laymen through unexplained terminology or an absence of simplistic illustrations to convey his points and enlighten his readers. Amazingly, as a writer Chamovitz has produced a decent way to give an intriguing yet brief survey on this topic which not only abridges his own decades of research but the general findings of the scientific community as well, all the while keeping his outline clear, his pace pleasantly brisk, and the presentation of his ideas easily accessible.

The book itself is divided into six chapters, each one respectively addressing what a plant sees, smells, feels, hears, how a plant knows where it is, and what a plant remembers. Interestingly, while the reader may have picked up this text with only plants in mind, they are bound to learn something about themselves in the process: while addressing whether a plant has a certain level of sensory perception, Chamovitz is forced to define these senses, especially beginning with how humans experience such phenomena, and then differentiate between how plants utilize the same type of sense differently regarding various aspects such as their biology, reaction, etc. Thus through an increased awareness of their own body, the reader is left with a better understanding of both similarities and differences in how plants interpret and react to the world around them.

Another layer of interest comes in Chamovitz's decision to relate how mankind discovered that plants have capabilities that resemble such actions as "seeing" and "smelling." From Darwin playing his bassoon for his plants to Thomas Knight strapping his seedlings onto a make-shift centrifuge in the form of the humble water-wheel, curious stories arise in *What A Plant Knows* of scientists who failed or succeeded, sometimes aided by pure accident, but eventually contributing to the knowledge mankind has been able to accumulate over the years regarding how plants act and react. As active and intelligent as the science in *What A Plant Knows* portrays plants, perhaps it is no wonder that Aristotle thought plants had souls!

Admirably, Chamovitz is not on a personal crusade to prove plants can sense things if the data is not there. Chamovitz's lack of bias seems evident in his chapter addressing whether plants can hear like humans; the chapter itself feels rather bare because in terms of research, Chamovitz admits, there is still far more work to be done. Chamovitz seems quite comfortable in acknowledging this and is in no hurry to postulate wild speculations in order to argue that plants have all the senses a human does. His goal is not to insist that plants experience the world just as humans do. Rather he wishes to prompt new ways of thinking about the senses, plants, and even humans themselves.

Ultimately, *What A Plant Knows* is a fascinating introduction for the popular reader to the world of sensory perception in the realm of plants. For someone unacquainted with the vast world of biological processes in the botanical field, this accessible text serves as an excellent way to both learn and appreciate more of the complex facets of plants themselves, as well as the field of botany, those who study it, and even the senses of humanity.—*Alexander Petty, Historian and Volunteer at the Botanical Research Institute of Texas, Fort Worth, Texas, U.S.A.*

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FLORA AND PHYTOGEOGRAPHY OF THE CAÑÓN DE ITURBIDE, NUEVO LEON, MEXICO

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ABSTRACT

The Cañón de Iturbide comprises folded mountains of sedimentary origin located in the Sierra Madre Oriental physiographic province in southeastern Nuevo León, and northeastern Mexico, in the Iturbide, Galeana, and Linares municipalities. This well preserved forest area has been considered by Arriaga-Cabrera et al. (2000) as the Priority Terrestrial Region 82. A floristic survey was conducted to provide a vouchered vascular plant list along with vegetation types of this important conservation area. In 30 sampling points, we recorded 113 families, 410 genera, and 768 taxa, (698 species and 70 infraspecific taxa). From this total, 128 species belong to the family Asteraceae, 99 to Fabaceae, and 55 to Poaceae. The phytogeography of the area corresponds mainly to neotropical, nearctic, and autochthonous species from arid lands, based on Rzedowski's (1962, 1978) classification. According to a cluster analysis and dendrogram, based on presence-absence of species, five main groups of plant associations are recognized: xeric scrublands, oak-pine forest (with different plant associations), piedmont scrub, Tamaulipan thorn scrub and agricultural lands (Miranda & Hernández 1963; Rzedowski 1978).

KEY WORDS: Cañón de Iturbide, flora, phytogeography, northeast Mexico

RESUMEN

El área denominada Cañón de Iturbide es un conjunto de sierras plegadas de origen sedimentario situadas en la región fisiográfica de la Sierra Madre Oriental al sureste del estado de Nuevo León y noreste de México, la cual abarca los municipios de Iturbide, Galeana y Linares. Ésta zona boscosa, bien conservada, ha sido considerada por Arriaga-Cabrera et al. (2000), como la Región Terrestre Prioritaria 82. La presente investigación consistió en la exploración de dicho sitio para hacer un reconocimiento taxonómico de las especies de flora vascular que componen sus tipos de vegetación. En 30 puntos de muestreo estratificado fueron registradas 113 familias, 410 géneros y 768 taxones (698 especies y 70 taxones intraespecíficos). De este total, 128 pertenecen a la familia Asteraceae, 99 a Fabaceae y 55 a Poaceae. La fitogeografía del área corresponde principalmente a especies neotropicales, neárticas y autóctonas de zonas áridas, en base a la clasificación de Rzedowski (1962, 1978). De acuerdo con el análisis de conglomerados y el dendrograma basado en la presencia-ausencia de especies, se reconocen cinco grupos principales de asociaciones vegetales: matorrales xerófilos, bosques de encino y pino (con diferentes asociaciones vegetales), matorrales submontanos, matorral espinoso tamaulipeco y tierras agrícolas (Miranda y Hernández 1963; Rzedowski, 1978).

PALABRAS CLAVE: Cañón de Iturbide, flora, fitogeografía, Noreste de México

INTRODUCTION

The Cañón de Iturbide area is located at the Gran Sierra Plegada in the State of Nuevo Leon and ranges from 700 to 2,900 m in elevation. The area is covered by forests and shrublands, in relatively good condition, and whose floristic components have not been studied deeply. The National Commission for the Knowledge and Use of Biodiversity (CONABIO) has designated it as the Priority Terrestrial Region 82. It represents an important area in the corridor of the Sierra Madre Oriental, connecting the preserved forests for the transit of carnivorous species such as black bear (*Ursus americanus*), cougar (*Puma concolor*), jaguar (*Panthera onca*), and jaguarundi (*Puma yagouaroundi*). It also serves as a migration corridor to the maroon-fronted parrot (*Rhynchopsitta terrisi*) which is endemic to the northern Sierra Madre Oriental. This study aims to contribute to the knowledge of the regional flora and its origin.

METHODS

Study area

The study was carried out in the Priority Terrestrial Region 82 (Arriaga-Cabrera et al. 2000). It embraces a surface area of 42,200 ha (Fig. 1) and is located at 24°40'19"–24°55'43"N and 99°45'36"–99°59'50"W. Its geology is constituted mainly of sedimentary calcareous, folded, anticlinal and synclinal rock layers from the upper cretaceous (Rzedowski 1978), giving rise to steep sierras with narrow central valleys. The dissolution of the rock by water has formed narrow canyons within the Cañón de Iturbide study area such as El Potosí, Jaures, Caribeño, Venado, Cañón Seco, Las Monedas, Pablillo, and La Escondida, as well as several important mountains, such as Sierra La Muralla, Sierra Borrada, Sierra Cieneguita, Sierra El Gabacho, Sierra El Novillo, and Sierra Santa María (INEGI 1986, 2010). The area is part of the San Fernando-Soto la Marina hydrographic region, in the Río San Fernando hydrographic subregion, and the Río Conchos-Chorreras basin (CONAGUA 2007). The climate varies from warm (low parts) to temperate (higher parts), and from wet to dry, in this case from East to West respectively. Climatic differences are caused by the Sierra Madre Oriental rising from the Llanura Costera del Golfo Norte (Gulf Coastal Plain) toward the Altiplano Mexicano (Mexican Plateau), producing a condensation effect, that generates rains in the eastern slope of the mountain chains where fog occurs commonly, while the western slopes develop a "rain shadow" with dry or semi-dry climate, forming low forest of oaks, known also as chaparral. The study area has three main climate types: (A)C(w_1) or semiwarm-subhumid, C(w_0) or temperate subhumid, and BS1h(x') or semiarid-temperate (García 1998). The main soils of the area are shallow lithosols, limited in depth to 10 cm above bedrock (FAO-UNESCO 1988). The main vegetation types are mixed forest (*Quercus-Pinus*), conifer forest (*Pinus*), broad leaf forest, piedmont scrub, xerophilous scrublands, and chaparral (Alanís 2004; Velazco 2009).

Field and lab work

Thirty sample sites representing all the plant communities previously recognized were randomly selected and georeferenced. Plant specimens were collected from July 2011 to April 2012. All specimens were deposited in herbarium in the Faculty of Forest Sciences, Linares, Nuevo León, Mexico (CFNL). Taxa were identified using several floristic studies for the area or near it as well as monographs for most genera (Banda 1974; Briones 1991; Estrada 2007; Estrada et al. 2012; González 1972, 2003; Hernández 1998; Luna et al. 2004; Martínez & Díaz Salas 1995; González-Medrano 1972; Mickel & Smith 2004; Puig 1991; Rojas 1965; Velazco 2009; Villarreal & Estrada 2008). We also consulted and used the databases for the CFNL herbarium, Hinton Herbarium (Galeana, N.L.), and TEX/LL, (Austin, Texas).

Sampled sites were compared according to their plant diversity. A species matrix based on presence (1)-absence (0) data was used for comparison among sites using Sörensen Similarity Coefficient (Mueller-Dumbois & Ellenberg 1974) by means of the polythetic agglomerative technique (Gauch 1982; Manly 1990) and the UPGMA method was used for cluster analysis, using the MVSP Package (KCS 2005). Vegetation types are according to Miranda & Hernández-Xolocotzi (1963) and Rzedowski (1978). Floristic affinities are according to (Rzedowski 1962, 1978), Hernández-Xolocotzi (1953), Briones (1991), and García (2009).

RESULTS AND DISCUSSION

Floristic composition

A total of 113 families, 410 genera, 698 species, and 70 infraspecific taxa of vascular plants were recorded. (Table 1, Appendix). Families with the highest number of genera, highest number of species, and genera with the highest number of species are shown in Tables 2, 3, and 4, respectively. Seven of the families (6%) include 43% and 49% of the genera and species, respectively, while the twelve most diversified genera include 23% of the total genera. The Magnoliophyta are the most common plants in Cañón de Iturbide, while Coniferophyta and Cycadophyta are the less diversified groups. The Asteraceae, Fabaceae, and Poaceae families are the most diversified families, and *Desmodium* (13), *Euphorbia* (12), *Dalea* (9), and *Quercus* (10) stand out as the most diversified genera.

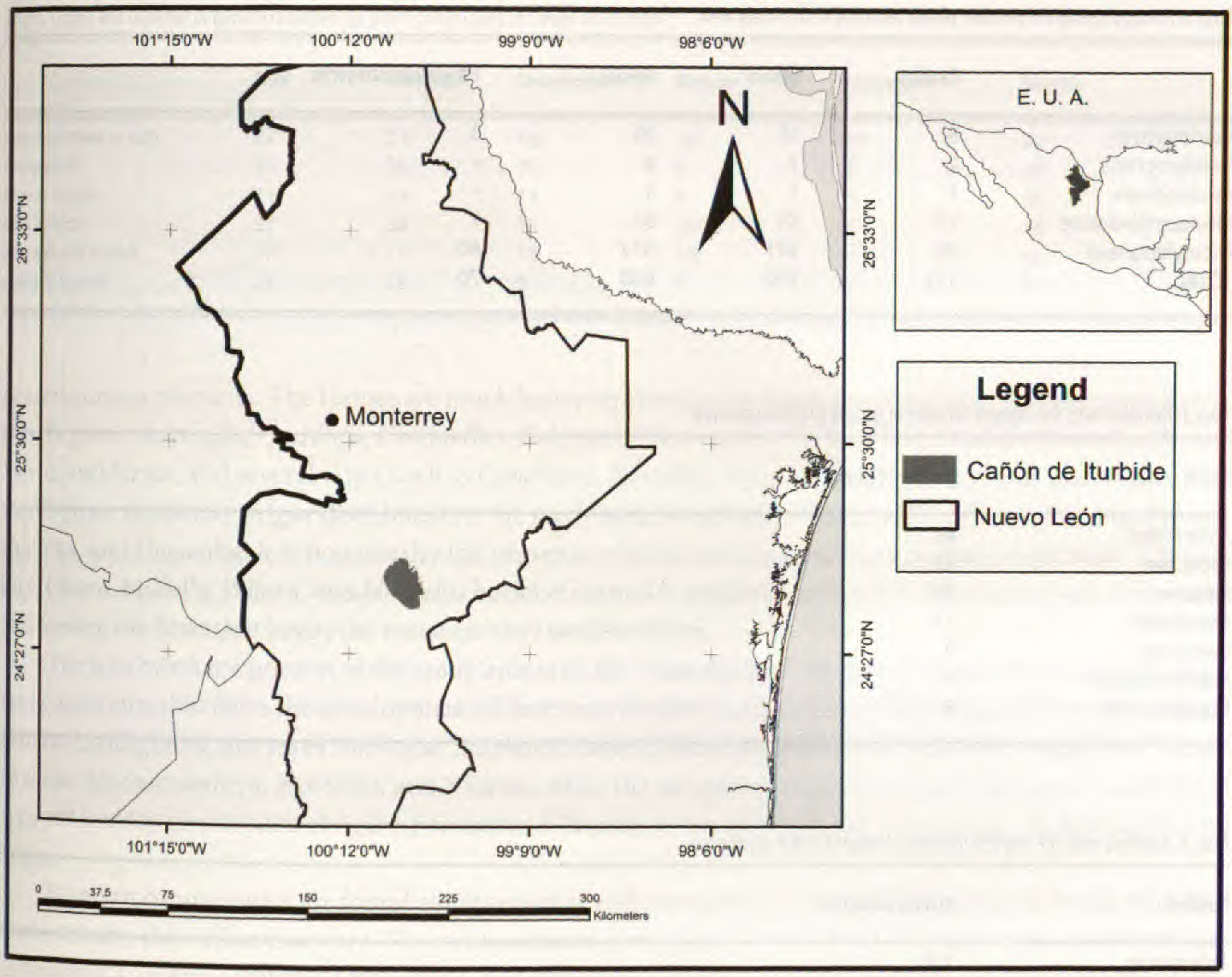

Fig. 1. Study area of Cañón de Iturbide, Nuevo Leon, Mexico.

Origin of the flora and phytogeography

The most common genera in the study area are from arid areas of the world and from Tropical America (Table 5). The piedmont scrub community contains the highest number of genera. This type of vegetation is located in lower parts of the area, at the foot of the mountains, in transition with Tamaulipan thorn scrub, and it is common to find genera from warm areas such as *Acacia*, *Bauhinia*, *Berberis*, *Zanthoxylum*, *Eheretia*, and *Phoebe*, as well as those belonging to the American tropics such as *Acaciella*, *Casimiroa*, *Caesalpinia*, *Amyris*, *Condalia*, *Cordia*, *Decatropis*, *Esenbeckia*, *Eysenhardtia*, *Gochnatia*, *Helietta*, *Persea*, and *Schaefferia*. Commonly found herbaceous species are *Abutilon*, *Acalypha*, *Indigofera*, *Waltheria*, *Phyllanthus*, *Priva*, *Tragia*, *Capsicum*, *Coursetia*, *Gilia*, *Lantana*, *Mimosa*, *Passiflora*, and *Verbesina*.

Several genera with nearctic and temperate affinity are most commonly found in the oak-pine forests and chaparral communities, in the highest parts of the mountains and in the western flanks, where it is common to find *Pinus* and *Quercus* as the dominant tree layer elements, associated with shrubby genera such as *Juniperus*, *Fraxinus*, *Cercis*, *Ceanothus*, *Prunus*, *Crataegus*, *Garrya*, and *Juglans*, while the herbaceous layer is mainly represented by *Aster*, *Conopholis*, *Hedeoma*, *Hymenoxys*, *Asclepias*, *Centaurium*, *Evolvulus*, *Hackelia*, *Packera*, *Parthenocissus*, *Philadelphus*, *Tagetes*, *Taraxacum*, *Urtica*, *Vitis*, *Artemisia*, and *Eryngium*, among others. Also, in the Chaparral community, *Quercus* is the genus dominant in the shrub layer, along with several genera of Rosaceae typical of temperate and dry areas such as *Amelanchier*, *Cercocarpus*, *Cowania*, *Crataegus*, *Vauquelinia*, and *Lindleya*.

The pure oak forests found in the study area have an important mix of neotropical elements followed by

Table 1. Principal groups of vascular plants recorded in the study area.

	Families	Genera	Species	Infraspecific categories
Pteridophyta	8	15	25	3
Coniferophyta	2	2	8	-
Cycadophyta	1	1	1	-
Monocotyledonae	17	51	92	7
Dicotyledoneae	85	341	572	60
TOTAL	113	410	698	70

Table 2. Families with the highest number of genera in the study area.

Family	Number of genera
Asteraceae	63
Fabaceae	41
Poaceae	28
Malvaceae	11
Cactaceae	9
Euphorbiaceae	9
Boraginaceae	8

Table 3. Families with the highest number of species in the study area.

Families	Number of species
Asteraceae	128
Fabaceae	99
Poaceae	54
Cactaceae	26
Euphorbiaceae	26
Malvaceae	20
Solanaceae	17

Table 4. Genera with the highest number of species in the study area.

Genera	Number of species
Desmodium	13
Euphorbia	12
Quercus	10
Dalea	9
Ageratina	8
Agave	7
Brickellia	7
Rhus	7
Erigeron	6
Ipomoea	6
Mimosa	6
Muhlenbergia	6

Table 5. Origin and number of genera recorded by plant community in Cañón de Iturbide.

	Calid	Temperate	Cosmopolitan	Mexican	Neotropical	Nearctic
Submontane scrub	87	21	18	10	101	42
Chaparral	15	39	10	2	14	47
Mixed forest	21	65	18	6	27	39
Oak forest	57	58	19	10	69	40
Xerophytic scrub	16	15	13	18	17	35
Gallery Forest	24	24	9	1	12	9

nearctic origin elements. The former are much better represented in the herbaceous layer by the genera *Ageratina, Begonia, Bouvardia, Castilleja, Cheilanthes, Cologania, Desmanthus, Desmodium, Mimosa, Phaseolus, Rivina, Salvia,* and *Stevia,* and several vines such as *Gonolobus, Ibervillea, Matelea, Melothria, Serjania,* and *Smilax.* Elements from temperate origin distributed in the study area are *Arbutus, Carya, Celtis, Cercis, Pistacia, Prunus, Quercus,* and *Ungnadia.* It is noteworthy the presence of ferns such as *Adiantum, Anemia, Asplenium, Cheilanthes, Llavea, Mildella, Pellaea,* and *Pleopeltis* because many are epiphytes adapted to live on the bark of the oaks and among the litter that keeps the moisture they need to thrive.

The southwestern portion of the study area is in the "rain shadow" of the sierra and shows evident semiarid conditions that favor the development of desert scrub plant communities, which include mostly nearctic genera, highlighting species of *Ambrosia, Baccharis, Bahia, Bouteloua, Dasylirion, Dyssodia, Lesquerella, Leucophyllum, Machaeranthera, Mortonia,* and *Nissolia.* Also, the xerophytic vegetation hosts the greater number of typical Mexican genera such as *Agave, Ferocactus, Glandulicactus, Mammillaria, Thelocactus, Turbinicarpus,* and *Yucca.*

Riparian communities are found along seasonal and permanent rivers and also in some creeks with seasonal streams that retain moisture. The most common genera from warm-areas found in these ecosystems are *Commelina, Cyperus, Digitaria, Oplismenus,* and *Paspalum,* but also present are genera with cosmopolitan distributions such as *Apium, Eleocharis, Lobelia, Rumex,* and *Samolus,* and even genera from temperate origin such as *Arundo, Astranthium, Coriandrum, Equisetum, Geranium, Iris, Rorippa, Seymeria,* and *Talinum.* The most evident and distinctive genera in the tree layer of the riparian areas are *Platanus, Salix,* and *Sambucus.*

According to the cluster analysis and the dendrogram (Fig. 2), based on presence-absence of species, five main groups of plant associations are recognized: xeric scrublands, oak-pine forest (with different plant associations), piedmont scrub, Tamaulipan thorn scrub and agricultural lands (Rzedowski 1978; Miranda & Hernández 1963).

Group I includes three sites located at xeric scrubland at an elevation of 1310 to 1500 m and is represented by the presence of the species *Acacia berlandieri, A. roemeriana, Agave lecheguilla, A. striata, Berberis trifoliolata, Echinocereus platyacanthus, Euphorbia antysiphilitica, Ferocactus hamatacanthus, Fraxinus greggii, Gochnatia hypoleuca, Jatropha dioica, Opuntia engelmannii, Prosopis laevigata, Tecoma stans,* and *Yucca filifera.*

Group II is a heterogeneous complex of sites where oaks and pines are the dominant elements at an elevation of 600 to 2000 m; however, it shows floristic differences. It includes six subgroups of plant associations. **Subgroup IIA** includes two sites dominated by 10–15 m tall pure oak-pine temperate forests at an elevation of 1000 m. The dominates include *Quercus affinis, Q. canbyi, Q. laceyi, Q. polymorpha, Pinus cembroides, P. pseudostrobus,* associated to *Carya ovata, Cercis canadensis, Juglans mollis, Juniperus deppeana, Pistacia mexicana,* and *Verbesina olsenii.* **Subgroup IIB,** made up of five sites (elevation of 1100 to 1500 m) and consists of a semi-dry oak scrubland in transition with pine forest. Subgroup IIb is similar to the Subgroup IIA but with a greater number of Rosaceae species. The dominant species in this subgroup are *Amelanchier denticulata, A. paniculata, Amyris madrensis, Buddleja cordata, Ceanothus fendleri, C. greggii, Dalea capitata, D. melantha, D, lutea, Juniperus angosturana, J. flaccida, Lindleya mespilioides, Pinus cembroides, P. pseudostrobus, Pistacia mexicana, Quercus fusiformis, Q. galeanensis, Q. laeta, Q. microlepis, Q. sideroxyla, Q. striatula,* and *Rhus virens.* These sites are

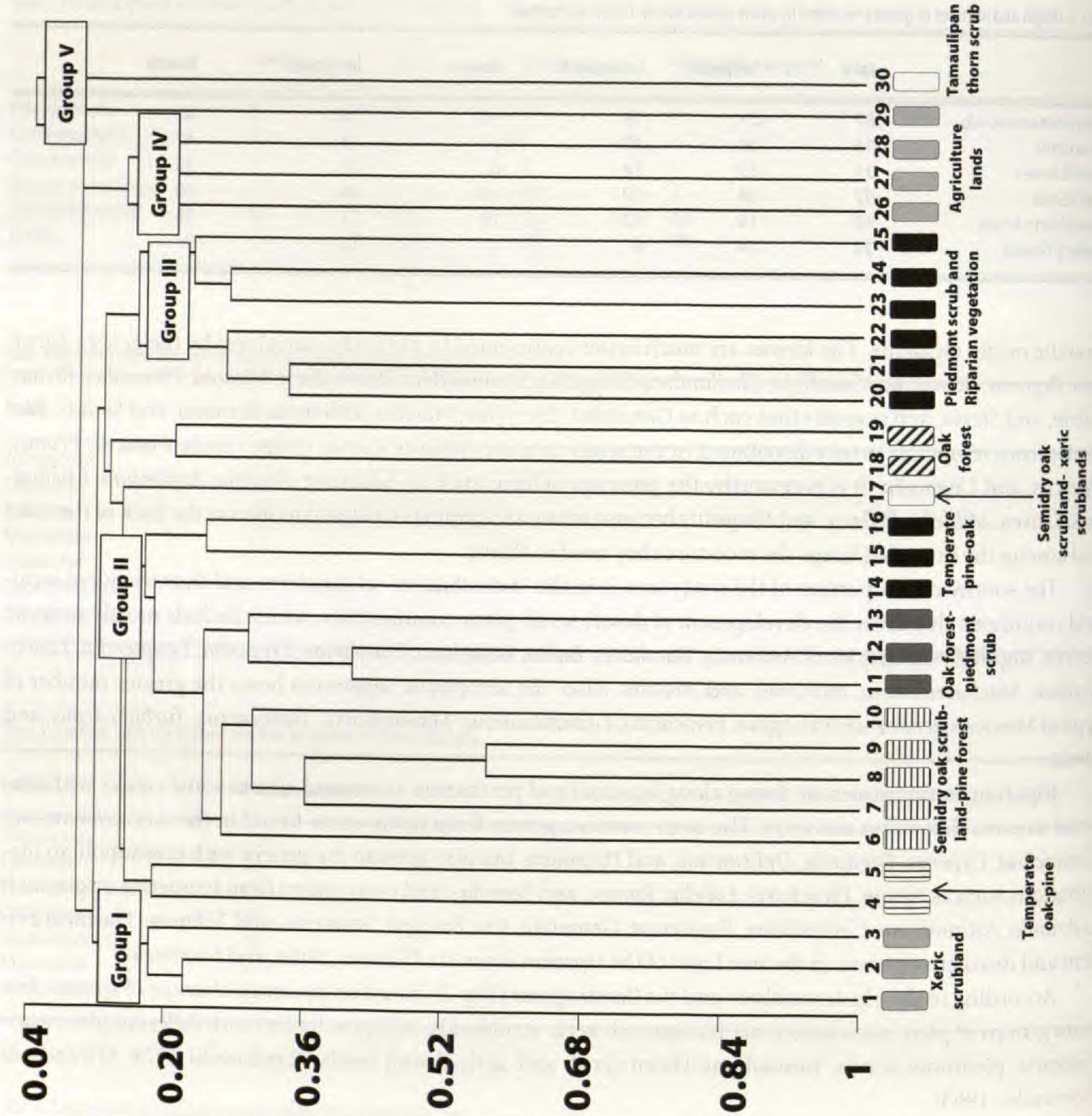

Fig. 2. Classification of the 30 sites sampled based on presence-absence of species. Five main groups of plant associations are recognized: xeric scrublands, oak-pine forest (with different plant associations), piedmont scrub, Tamaulipan thorn scrub and agricultural lands

mainly located at 1600 to1900 m altitude. **Subgroup IIC** includes three sites of an oak-forest and piedmont scrub physiognomy, and constitutes a heterogeneous plant community where low trees (8–10 m) and tall shrubs (3–6 m) coexist. The main species found here are *Acacia coulteri, Casimiroa pringlei, C. greggii, Cordia boissieri, Decatropis bicolor, Esenbeckia berlandieri, Juglans mollis, Persea longipes, Phoebe tampicensis, Quercus polymorpha, Q. rizophylla, Ungnadia speciosa,* and *Zanthoxylum fagara.* This plant community develops in medium altitudes from 600 to 850 m. A small **Subgroup IID** includes three sites constituting a pine-oak forest similar to those of Subgroup IIA but with a greater number of *Pinus* species as dominant, including *Arbutus xalapensis, Berberis madrensis, Buddleia scordioides, Carya illinoinensis, Crataegus rosei, Fraxinus cuspidata, Garrya ovata, Juniperus flaccida, Pinus greggii, P. peudostrobus P. strobiformis, P. teocote, Prunus serotina, Quercus galeanensis, Q. rizophylla,* and *Rhus pachyrrachis.* These sites are located at 1320 to 2000 m. **Subgroup IIE** consists of only one site characterized by xeric oak scrubland and dominated an elevation of 1400 m by *Agave lech-*

eguilla, Comarostaphylis polifolia, Croton ciliato-glandulifer, Dasylirion berlandieri, Juniperus deppeana, O. engelmannii, Painteria eleachistophylla, Pistacia mexicana, Tecoma stans, Vauquelinia corymbosa ssp. *heterodon*, and *Yucca treculeana*. **Subgroup IIF** included two sites of pure oak forest located at 750 to 950 m and is dominated by *Dioon angustifolium* in the lower strata and by *Juglans mollis, Esenbeckia berlandiri, Quercus canbyi*, and *Q. rizophylla* in the higher strata. Some epiphytes were also recorded such as *Tillandsia bartramii, T. recurvata*, and *T. usneoides*.

Group III includes six sites reaching 600 to 1100 m along the Cabezones-Potosi canyon, showing a 4–5 m tall piedmont scrub physiognomy with abundant thorny and non-thorny species. Several species are characteristic of this plant community, highlighting species of the genera *Acacia, Bauhinia, Buddleja, Celtis, Cercis, Colubrina, Cordia, Decatropis, Diospyros, Ebenopsis, Ehretia, Erythrina, Esenbeckia, Havardia, Helietta, Phoebe, Ungnadia*, and *Zanthoxylum*, but also, when adjacent riparian habitats, they share several species such as *Adiantum capillus-veneris, Cyperus minimae, C. odoratus, C. thyrsiflorus, Equisetum hyemale, Lobelia cardinalis, Platanus rzedowskii, Rorippa nasturtium-aquaticum, Sambucus nigra* ssp. *canadensis, Salix jaliscana*, and *S. nigra*, as the most evident.

Group IV includes four sites located at medium altitudes ranging from 1500 to 1530 m in agriculture lands in Laguna de Santa Rosa, and adjacent to the semi-dry oak scrubland. It is dominated by weed species in the herbaceous strata such as *Abutilon hypoleucum, Alternanthera caracasana, Amaranthus hybridus, Ambrosia psilostachya, Anagallis arvensis, Anoda cristata, Astragalus hypoleucus, Argemone mexicana, Bidens ferulifolia, Boerhavia anysophylla, Bouchetia erecta, Cirsium vulgare, Calyptocarpus vialis, Dyssodia papposa, Gaura coccinea, Helianthus annus, Ipomoea coccinea, Kallstroemia parvifolia, Lactuca serriola, Meximalva filipes, Nicotiana trigonophylla, Oenothera rosea, Parthenium incanum, Ricinus communis, Solanum eleagnifolium, Taraxacum officinale, Urtica chamaedryoides, Verbena carolina*, and *Zinnia peruviana*.

Finally, **Group V** corresponds to a single site in the lowest part of the study area ranging from 600 to 650 m on the boundary with Tamaulipan thorny scrub. This group shows species not found in the other site's samples such as *Acacia amentacea, Acaciella angustissima, Bernardia* myricifolia, *Caesalpinia mexicana, Capsicum annuum* var. *minus, Canavallia villosa, Celtis laevigata, C. pallida, Colubrina greggii, Croton cortesianus, C. fruticulosus, Dyospyros texana, Ehretia anacua, Hibiscus martianus,Karwinskia humboldtiana, Randia rhagocarpa*, and *Schaefferia cuniefolia*.

Endemism and protection status

The study area hosts at least five endemic species for Nuevo León Mexican state: *Notholaena leonina*, living in oak-pine forests, in the Cañón Arroyo Seco; *Verbesina olsenii*, inhabiting mainly oak forest, adapted to live in moist ravines, near the Caracol Waterfall; *Anoda leonensis*, inhabiting piedmont scrub in transition to oak forests, at La Palma and Cañón El Caribeño; *Thelocactus tulensis*, recorded in the rosetophyllous desert scrub, found in dry slopes of mountains, near the town Potrero Prieto; and *Cardamine auriculata*, inhabiting the piedmont scrub near Cañón El Caribeño. In addition *Dioon angustifolium*, is narrowly endemic to the mountains of Iturbide and Linares counties in Nuevo León, and to the Sierra de San Carlos, Tamaulipas (Astorga et al 2005). Also, as part of this work, a new Asteraceae species was discovered: *Verbesina lanulosa* (in press), which lives in the transition between the piedmont forest and oak forests near the settlement of La Salitrera. The new species was recorded in the piedmont scrub on rocky hillsides, with high sun exposure. From the total species known for this area we recorded seven species protected by Mexican laws (NOM - 059 SEMARNAT 2010) (Table 6).

CONCLUSIONS

The heterogeneous topography and climates over all the study area allow for the development of rich plant diversity as well as contrasting plant communities and different life forms. The plains, mountains, creeks, and cliffs create different and variable ecosystems that are home to countless species of very different origins. The classification of vegetation allowed us to recognize different patterns of plant association based on plant diversity. The most diverse plant vegetation types were the oak and the oak-pine forest, although in this plant community were more sampling sites, our results agree with those of Estrada (2007), who found that of all sampled

TABLE 6. Species protected by Mexican law in the study area.

Species	Protection Status
Agave bracteosa S. Watson ex Engelm.	Endemic and threatened
Brahea berlandieri Bartlett	Endemic and special protection
Dioon angustifolium Miq.	Endemic and endangered
Echinocactus platyacanthus Link & Otto	Endemic and special protection
Litsea glauscecens Kunth	Non endemic and endangered
Pinus strobiformis Engelm.	Non endemic and special protection
Thelocactus tulensis (Poselger) Britton & Rose	Endemic and threatened

vegetation types (which are close to our study area), mixed forests of oak and conifer always kept greater diversity of species. Nearby areas with similar plant communities are found in the south of Nuevo Leon (Cerro Peña Nevada) and Tamaulipas (Sierra de San Carlos), and both of them contain shrub and forest communities. In Peña Nevada, Moreno-Talamantes (2012) recorded 485 taxa, most of them of nearctic origin, while in the Sierra de San Carlos, Martinez (1995) recorded 676 taxa, most of them from neotropical origin: The Cañón de Iturbide shares strong similarities with both of them, but its flora is richer in diversity since it has all ecosystems found in both areas, and it can be highlighted as an area for conservation of its plant diversity and its endemism. Five endemic species in the State of Nuevo Leon were recorded in the area: *Anoda leonensis, Cardamine auriculata, Dioon angustifolium, Notholaena leonina, Thelocactus tulensis*, and *Verbesina olsenii*. From the 768 taxa recorded, seven of them are protected by NOM 059-SEMARNAT-2010: *Agave bracteosa, Brahea berlandieri, Dioon angustifolium, Echinocactus platyacanthus, Litsea glauscecens, Pinus strobiformis*, and *Thelocactus tulensis*. The discovery of a new species, Verbesina *lanulosa* (in press), in this area shows that still more botanical work is necessary to complete the floristic studies of northeastern Mexico. The plant diversity recorded in the Cañón de Iturbide includes genera and species from different origins, but the tropical elements are quantitatively the most important ones, since they represent about 52% of families, 68% of genera, and 32% of the species, and they are well represented in the different plant communities, especially piedmont scrub, oak forest, and oak-pine forests.

APPENDIX

Floristic list of the Cañón de Iturbide, Nuevo Leon, Mexico. All specimens are deposited in the Herbarium CFNL (Linares, Nuevo Leon, Mexico).

PTERIDOPHYTA

Anemiaceae

Anemia mexicana Klotzsch, E.E. 21049, 21219.

Aspleniaceae

Asplenium resiliens Kunze, M.S. 59.

Equisetaceae

Equisetum hyemale L. var. *affine* (Engelm.) A.A. Eaton, E.E. 21846.

Ophioglossaceae

Botrychium schaffneri Underw., M.S. 1374.

Polypodiaceae

Pleopeltis polylepis (Roem ex. Kunze) T. Moore var. *erythrolepis* (Weath.) T. Wendt, E.E. 21880.

Pleopeltis polypodioides (L.) E.G. Andrews & Windham var. *michauxianum* (Weath) E.G. Andrews & Windham, E.E. 21206; M.S. 497.

Pleopeltis thyssanolepis (A. Braun ex Klotszch) E.G. Andrews & Windham, M.S. 732.

Pteridaceae

Adiantum capillus-veneris L. E.E. 21435, 21888.

Adiantum tricholepis Fée, E.E. 21209, 1257.

Astrolepis integerrima (Hook.) D.M. Benham & Windham E.E. 21181, 21622.

Astrolepis sinuata (Lag. ex Sw.) D.M. Benham & Windham M.S. 14, M.S. 474

Chelianthes alabamensis (Buckley) Kunze, E.E. 21599

Cheilanthes bonariensis (Willd.) Proctor E.E. 21180.

Cheilanthes leucopoda Link, E.E. 21860.

Cheilanthes microphylla (Sw.) Sw., E.E. 21145, 21210, 21604.

Llavea cordifolia Lag., E.E. 21138, 21504, 21626, 21904.

Mildella fallax (M. Martens & Galeotti) G.L. Nesom E.E. 21120.

Notholaena bryopoda Maxon, E.E. 21051.

Notholaena leonina Maxon, E.E. 21228.

Notholaena standleyi Maxon, M.S. 1413.

Pellaea atropurpurea (L.) Link, E.E. 21153.

Pellaea microphylla Mett. ex Kuhn, M.S. 52.

Pellaea ovata, (Desv.) Weath. E.E. 21859.

Pteridium aquilinum (L.) Kuhn, E.E. 21502, 21887.

Pteridium caudatum (L.) Maxon, M.S. 1618.

Selaginellaceae

Selaginella lepidophylla (Hook. & Grev.) Spring, E.E. 21075, 21610.

Selaginella pilifera A. Braun, E.E. 21076, 21244, 21881.

Thelypteridaceae
Thelypteris puberula (Baker) C.V. Morton, M.S. 1094.

GYMNOSPERMAE

Cupressaceae
Juniperus angosturana R.P. Adams., M.S. 309.
Juniperus depeanna Steud., E.E. 21667.
Juniperus flaccida Schltdl., E.E. 21624.

Pinaceae
Pinus cembroides Zucc., E.E. 21603.
Pinus greggii Engelm. ex Parl., M.S. 1459.
Pinus pseudostrobus, Lindl. E.E. 20894, 260.
Pinus strobiformis Engelm., M.S. 1403.
Pinus teocote Schltdl. & Cham, M.S. 261.

Zamiaceae
Dioon angustifolium Miq., E.E. 21233, 238.

MONOCOTYLEDONEAE
(16 families and 50 genera)

Agavaceae
Agave americana L., M.S. 636, 674, 677.
Agave americana L. ssp. *protoamericana* Gentry, M.S. 731.
Agave bracteosa S. Watson ex Engelm., M.S. 1505.
Agave lecheguilla Torr., M.S. 240.
Agave gentry B. Ullrich, M.S. 713.
Agave scabra Ortega, E.E. 21621, 957.
Agave striata Zucc. M.S. 743.
Yucca filifera Chabaud, M.S. 654.
Yucca linearifolia Clary, M.S. 1476.
Yucca treculeana Carrière, M.S. 632.

Alliaceae
Allium kunthii G. Don, M.S. 1171.

Amaryllidaceae
Zephyranthes drummondii D. Don, E.E. 21913.

Anthericaceae
Echeandia flavescens (Schult. & Schult. f.) Cruden, M.S. 883.
Echeandia mexicana Cruden, M.S. 1514.

Araceae
Xanthosoma robustum Schott, M.S. 232.

Arecaceae
Brahea berlandieri Bartlett, M.S. 1110.
Brahea dulcis (Kunth) Mart, E.E. 21273a.

Bromeliaceae
Hechtia podantha Mez, M.S. 1246.
Tillandsia bartramii Elliott, E.E. 21196, 21743.
Tillandsia parryi Baker, E.E. 21222.
Tillandsia recurvata (L.) L., E.E. 21098.
Tillandsia usneoides (L.) L., E.E. 21235.

Commelinaceae
Commelina erecta L., E.E. 21923.
Commelina tuberosa L., E.E. 21087.
Tradescantia crassifolia Cav. M.S. 55.
Tradescantia pringlei S. Watson, M.S. 1288, M.S. 1558.

Cyperaceae
Carex spissa L.H. Bailey var. *ultra* (L.H. Bailey) Kük, E.E. 21897.
Carex schiedeana Kunze, E.E. 21806.
Cyperus manimae Kunth, E.E. 21239, 21266.
Cyperus odoratus L., M.S. 1288.
Cyperus thyrsiflorus Jungh., M.S. 1603.
Eleocharis montevidensis Kunth E.E. 21812.

Hypoxidaceae
Hypoxis mexicana Schult. & Schult., M.S. 1359.

Liliaceae
Calochortus barbatus (Kunth) J.H. Painter, M.S. 1548.

Melanthiaceae
Schoenocaulon macrocarpum Brinker, E.E. 21158.
Schoenocaulon texanum Scheele, E.E. 21189.

Nolinaceae
Dasylirion berlandieri S. Watson, M.S. 785, M.S. 1018.
Dasylirion leiophyllum Engelm, ex Trel., M.S. 1018.
Dasylirion texanum Scheele, M.S. 865.

Orchidaceae
Malaxis fastigiata (Rchb. f.) Kuntze, M.S. 297.
Mesadenus chiangii (M.C. Johnst.) Garay, M.S. 1404.

Poaceae
Achnatherum eminens (Cav.) Barkworth, M.S. 592.
Agrostis verticillata Vill., E.E 21869, 21885; M.S. 1412.
Andropogon scoparius Michx., E.E. 21118.
Aristida pansa Wooton & Standl., M.S. 27.
Aristida purpurea Nutt. var. *purpurea*, E.E. 21047, 21052, 21058; M.S. 60.
Aristida roemeriana Scheele, E.E. 21255; M.S. 1356.
Aristida schiedeana Trin. & Rupr. var. *schiedeana*, M.S. 60.
Arundo donax L., E.E. 21765.
Bothriochloa barbinodis (Lag.) Herter, M.S. 1034.
Bothriochloa saccharoides (Sw.) Rydb, M.S. 1169.
Botriochloa laguroides (DC.) Herter var. *laguroides*, M.S. 1605.
Bouteloua chondrosioides (Kunth) Benth. ex S. Watson, E.E. 21055a.
Bouteloua curtipendula (Michx.) Torr., E.E. 21437, 21926.
Bouteloua repens (Kunth) Scribn. & Merr., E.E. 21199.
Bromus anomalus Rupr. ex E. Fourn., M.S. 347.
Cenchrus incertus M.A. Curtis, E.E. 21220.
Chloris submutica Kunth, M.S. 1375.
Digitaria bicornis (Lam.) Roem. & Schult. M.S. 1606.
Digitaria ciliaris (Retz.) Koeler, E.E. 21152.
Digitaria cognata (Schult.) Pilg., E.E. 21724.
Eleusine indica (L.) Gaertn., M.S. 22.
Eragrostis cilianensis (All.) Vignollo ex Janch., E.E. 21264, 21272.
Eragrostis intemredia Hitchc., E.E. 21705.
Erioneuron nealleyi (Vasey) Tateoka, M.S. 26.
Leptochloa dubia (Kunth) Nees, M.S. 582.
Leptochloa fusca (L.) Kunth, M.S. 583.
Leptochloa mucronata (Michx.) Kunth, M.S. 584.
Melinis repens (Willd.) Zizka, E.E. 21122, 21522, 21655.
Muhlenbergia dubia E. Fourn., E.E. 21500.
Muhlenbergia lehmanniana Henrard, E.E. 21174.
Muhlenbergia mexicana, (L.) Trin., E.E. 21119.
Muhlenbergia pauciflora Buckley, E.E. 21782.
Muhlenbergia repens (J. Presl) Hitchc., M.S. 47.
Muhlenberia spiciformis Trin., M.S. 1606.
Muhlenbergia tenuifolia Kunth (Kunth)., M.S. 1425.
Oplismenus hirtellus (L.) P. Beauv. ssp. *hirtellus*, M.S. 235.
Oplismenus hirtellus (L.) P. Beauv. ssp. *setarius* (Lam.) Mez ex Ekman, M.S. 257.
Panicum acuminatum Sw., E.E. 21729, 21905.
Panicum bulbosum Kunth, E.E. 21188.
Paspalum notatum Alain ex Flüggé, M.S. 3.
Paspalum publiflorum, Rupr.ex E. Fourn., E.E. 21825.
Paspalum setaceum Michx. var. *ciliatifolium* (Michx.) Vasey, M.S. 1585
Piptochaetium fimbriatum (Kunth) Hitchc., M.S. 1532
Poa annua L., E.E. 21441.

Poa pratensis L., M.S. 1321.
Setaria geniculata P. Beauv., E.E. 21443.
Setaria leucopila (Scribn. & Merr.) K. Schum. M.S. 20, 845.
Setaria parviflora (Poir.) Kerguelén, E.E. 21238.
Setaria viridis (L.) P. Beauv., E.E. 21438.
Sorghum halepense (L.) Pers., E.E. 21857.
Tragus berteronianus Schult., E.E. 21520.
Tridens pilosus (Buckley) Hitchc., E.E. 21057.
Tridens texanus (S. Watson) Nash, E.E. 21048.
Trisetum spicatum (L.) K. Richt., M.S. 1376.
Zea mays L., M.S. 1322.

Smilacaceae
Smilax bona-nox L., E.E. 21140.
Smilax lanceolata L., E.E. 21850.

Xanthorrhoeaceae
Aloe vera (L.) Burm. f., M.S. 209.
Asphodelus fistulosus L., E.E. 21601, 646.

DICOTYLEDONEAE
(85 families and 339 genera)

Acanthaceae
Carlowrightia texana Henrickson & T.F. Daniel, E.E. 21107, 21747; M.S. 210.
Dyschoriste decumbens (A. Gray) Kuntze, M.S. 8.
Dyschoriste linearis (Torr. & A. Gray) Kuntze var. *linearis*, M.S. 1043.
Dyschoriste poliodes Leonard & Gentry , E.E. 21692, 21834.
Dyschoriste schiedeana (Nees) Kuntze var. *schiedeana*, M.S. 1174, 1388.
Elytraria imbricata (Vahl) Pers., E.E. 21072, 21214.
Jacobinia incana (Nees) Hemsl., E.E. 21236; M.S. 248
Ruellia corzoi Tharp & F.A. Barkley, M.S. 534.
Ruellia nudiflora (Engelm. & A. Gray) Urb., E.E. 21674.
Ruellia occidentalis (A. Gray) Tharp & F.A. Barkley, E.E. 21237.
Siphonoglossa greggii Greenm. & C. H. Thomps., E.E. 21201, 21204.
Tetramerium nervosum Nees, E.E. 21060; E.E. 21259

Adoxaceae
Sambucus nigra L. ssp *canadensis* (L.) R. Bolli, M.S. 1416.

Amaranthaceae
Alternanthera caracasana Kuntze, E.E. 21722; M.S. 1142.
Amaranthus hybridus L., E.E. 21780.
Iresine calea Standl., E.E. 21605.
Iresine cassiniiformis S. Schauer, E.E. 21745, 21855, 21903.
Iresine diffusa Humb. & Bonpl. ex Willd., E.E. 21170.

Anacardiaceae
Pistacia mexicana Kunth, E.E. 21211, 21596; M.S. 501
Rhus aromatica Aiton var. *trilobata* (Nutt.) A. Gray, E.E. 21901.
Rhus eximia (Greene) Standl., M.S. 273.
Rhus microphylla Engelm., E.E. 21771, 45.
Rhus pachyrrachis Hemsl., M.S. 267, 671.
Rhus radicans (L.) Kuntze, M.S. 248.
Rhus toxicodendron L. var. *quercifolia* Michx., M.S. 712.
Rhus virens Lindh. ex A. Gray var. *virens*, E.E. 21136, 21229, 21612.

Apiaceae
Apium graveolens L., E.E. 21442.
Coriandrum sativum L., M.S. 959, 1099.
Cyclospermum leptophyllum (Pers.) Sprague, E.E. 21912.
Donnellsmithia juncea (Humb. & Bonpl. ex Spreng.) Mathias & Constance, M.S. 1297.
Eryngium heterophyllum Engelm., M.S. 1451.
Tauschia aff. *bicolor* Constance & Bye, M.S. 1477.

Apocynaceae
Apocynum cannabinum L., M.S. 1421.
Asclepias angustifolia Schweigg., E.E. 21733, 21919.
Asclepias linaria Cav., E.E. 21797, 21820.
Asclepias linearifolia Pavon ex Decaisne in de Candolle pro syn., M.S. 1355.
Asclepias oenotheroides Schltdl. & Cham, M.S. 1463.
Asclepias verticillata L., M.S. 1369.
Cynanchum barbigerum (Scheele) Shinners, E.E. 21487.
Funastrum barbatum (Mart. ex E. Fourn.) Schltr., M.S. 1452.
Gonolobus gonoloboides (Greenm.) Woodson, M.S. 733, 906, 1095.
Mandevilla andrieuxii (Müll. Arg.) Hemsl., M.S. 1381.
Mandevilla karwinskii (Müll. Arg.) Hemsl., E.E. 21789.
Matelea pilosa (Benth.) Woodson, M.S. 1480.
Matelea reticulata (Engelm. ex A. Gray) Woodson, E.E. 21871.

Aquifoliaceae
Ilex rubra S. Watson, M.S. 282, 691.

Aristolochiaceae
Aristolochia wrightii Seem., M.S. 54.

Asteraceae
Acourtia runcinata (Lag. ex D. Don) B.L. Turner, E.E. 21616, 21619.
Ageratina espinosarum (A.Gray) R.M.RKing & H.RRob. var. *espinosarum*, E.E. 21788; M.S. 224.
Ageratina espinosarum (A.Gray) R.M. King & H. Rob. var. *subintegrifolia* A.Gray) R.M. King & H.RRob., M.S. 1607.
Ageratina havanensis (Kunth) R.M. King & H. Rob., E.E. 21858.
Ageratina nesomii B.L. Turner, M.S. 268a.
Ageratina petiolaris (Moc. ex DC.) R.M. King & H. Rob., M.S. 1529.
Ageratina saltillensis (B.L. Rob.) R.M. Kimg & H. Rob., E.E. 21154, 21161.
Ageratina scorodonioides (A. Gray) R.M. King & H. Rob., M.S. 1608.
Ageratina viburnoides (DC.) R.M. King & H. Rob., E.E. 21481.
Ambrosia confertiflora DC., M.S. 376.
Ambrosia psilostachya DC., E.E. 21039, 21089
Aphanostephus ramosissimus DC., var. *ramosissimus*, E.E. 21708; M.S. 56.
Aphanostephus ramosissimus DC., var. *humilis* (Benth.) B.L. Turner & Birdsong, M.S. 1609.
Artemisia frigida Willd., M.S. 1431.
Aster asteroides (DC.) Kuntze, M.S. 590.
Astranthium splendens De Jong, M.S. 1554.
Baccharis pteronioides DC., M.S. 1433.
Baccharis salicina Torr. & A. Gray, E.E. 219121.
Bahia autumnalis Ellison, E.E. 21849, 21917.
Baltimora geminata (Brandegee) Stuessy, M.S. 1572.
Barkleyanthus salicifolius (Kunth) H. Rob. & Brettell, M.S. 714.
Berlandiera lyrata Benth. var. *lyrata* Benth., E.E. 21142.
Berlandiera lyrata Benth. var. *macrophylla* A. Gray, M.S. 1410.
Bidens ferulifolia (Jacq.) DC., M.S. 1415.
Bidens aurea (Aiton) Sherff, M.S. 853.
Brickellia eupatorioides (L.) Shinners var. *chlorolepis* (Woot. & Standl.) B.L. Turner, E.E. 21217.
Brickellia grandiflora (Hook.) Nutt., M.S. 574.
Brickellia laciniata A. Gray, M.S. 1173.
Brickellia lemmonii A. Gray var. *conduplicata* (B.L. Rob.) B.L. Turner, M.S. 1542.
Brickellia saltillensis B.L. Rob, M.S. 16.
Brickellia spinulosa (A. Gray) A. Gray, E.E. 21679.
Brickellia veronicifolia (Kunth) A. Gray, var. *petrophila* (B.L. Rob.) B.L. Rob, M.S. 161, 512.
Calyptocarpus vialis Less., E.E. 21263, 21615, 21658.
Chaetopappa bellioides (A. Gray) Shinners, E.E. 21070, 21207, 21248.
Chaptalia texana Greene, M.S. 1464.

Chrysactinia mexicana A. Gray, M.S. 1426.
Chrysactinia truncata S. Watson, E.E. 21046.
Cirsium acrolepis (Petr.) G.B. Ownbey, M.S. 1547.
Cirsium pringlei (S. Watson) Petr., M.S. 1483, 1547.
Cirsium texanum Buckley, M.S. 1462.
Cirsium vulgare (Savi) Ten., M.S. 1083.
Dyssodia papposa (Vent.) Hitchc., M.S. 1518.
Dyssodia pinnata (Cav.) B.L. Rob., E.E. 21899, 21907.
Dyssodia pinnata (Cav.) B.L. Rob. var. *glabrescens* Strother, M.S. 1465.
Engelmannia pinnatifida Nutt., M.S. 1409.
Erigeron basilobatus S.F. Blake, M.S. 423.
Erigeron calcicola Greenm. M.S. 471.
Erigeron dryophyllus A. Gray, E.E. 21163.
Erigeron flagellaris A. Gray, M.S. 498.
Erigeron pulchellus Michx., M.S. 528.
Erigeron veracruzensis G.L. Nesom, E.E. 21128, 21177, 21183.
Gaillardia pulchella Foug., M.S. 1481.
Gnaphalium brachypterum DC., E.E. 21121.
Gnaphalium canescens DC., M.S. 311.
Gnaphalium chilense Spreng., M.S. 247, 453.
Gnaphalium flavocephalum G.L. Nesom E.E. 21131a.
Gnaphalium semiamplexicaule DC., M.S. 430.
Gochnatia hypoleuca (DC.) A. Gray, E.E. 21613, 21672.
Grindelia inuloides Willd. var. *inuloides*, M.S. 1041.
Grindelia microcephala DC., M.S. 1552.
Grindelia obovatifolia S.F. Blake, M.S. 1545.
Grindelia tenella Steyerm., M.S. 1555.
Gymnosperma glutinosum (Spreng.) Less., E.E. 21242, 21600.
Helenium amarum var. *badium* (A. Gray ex S. Watson) Waterf., M.S. 598.
Helenium quadridentatum Labill., M.S. 1544.
Helenium elegans DC. var. *amphilobum* (A. Gray) Bierner, M.S. 1447.
Helianthella gypsophila B.L. Turner var. *calcarea* B.L. Turner, M.S. 1586.
Helianthus annuus L., M.S. 1553.
Heterotheca mucronata Harm., M.S. 605.
Heterotheca subaxillaris (Lam.) Britton & Rusby, M.S. 1449.
Heterotheca villosa (Pursh) Shinners, M.S. 1571.
Hieracium abscissum Less., E.E. 21124.
Hieracium mexicanum Less., M.S. 936.
Hieracium pringlei A. Gray, M.S. 9361408.
Hymenoxys insignis (A. Gray) Cockerell, M.S. 1084.
Hymenoxys linearifolia Hook.var. *linearifolia*, M.S. 1546.
Hymenoxys odorata DC., M.S. 1399.
Hymenoxys scaposa (DC.) K.F. Parker var. *argyrocaulon* K.F. Parker, M.S. 1084, 1470.
Koanophyllon galeana (B.L. Turner) B.L. Turner, E.E. 21127.
Lactuca serriola L., M.S. 862.
Loxothysanus pedunculatus Rydb., M.S. 1551.
Machaeranthera pinnatifida (Hook.) Shinners, M.S. 61.
Machaeranthera scabrella (Greene) Shinners, M.S. 1568.
Melampodium divaricatum (Rich. in Pers.) DC., M.S. 1585
Melampodium perfoliatum (Cav.) Kunth, E.E. 21872.
Packera tampicana (DC.) C. Jeffrey, M.S. 588.
Parthenium argentatum A. Gray, M.S. 1397.
Parthenium confertum A. Gray, M.S. 164.
Parthenium confertum A. Gray var. *lyratum* (A. Gray) Rollins, M.S. 1611.
Parthenium hysterophorus L., E.E. 21080.
Parthenium incanum Kunth, E.E. 22367.
Pinaropappus multicaulis Brandegee, M.S. 978.
Pinaropappus roseus (Less.) Less., M.S. 19.
Polymnia uvedalia (L.) L., M.S. 1448.
Porophyllum ruderale (Jacq.) Cass., M.S. 400.
Roldana aschenborniana (S. Schauer) H. Rob. & Brettell, M.S. 308.
Roldana lobata La Llave, M.S. 823.
Sanvitalia ocymoides DC., M.S. 866.
Senecio coahuilensis Greenm., E.E. 21886.
Senecio sundbergii B.L. Turner, E.E. 21668.
Simsia amplexicaulis (Cav.) Pers., E.E. 21910.
Simsia calva (A. Gray & Engelm.) A. Gray, M.S. 1556.
Solidago altissima L., E.E. 21864.
Sonchus asper (L.) Hill, E.E. 21754, 21763.
Sonchus oleraceus L., M.S. 1224.
Stevia berlandieri A. Gray var. *berlandieri*, E.E. 21113.
Stevia micrantha Lag., M.S. 1319.
Stevia serrata Cav., M.S. 597.
Stevia pliosa Lag., M.S. 439.
Symphyotrichum expansum (Poepp. ex Spreng.) G.L. Nesom, M.S. 1542.
Tagetes lucida Cav., M.S. 190.
Tamaulipa azurea (DC.) R.M. King & H. Rob., M.S. 587.
Taraxacum officinale L., M.S. 611, 990.
Thelesperma simplicifolium (A. Gray) A. Gray, M.S. 1469.
Thymophylla pentachaeta (DC.) Small, M.S. 375.
Thymophylla setifolia Lag., M.S. 1428.
Tridax procumbens L., E.E. 21117.
Tridax coronopifolia (Kunth) Hemsl., M.S. 262.
Verbesina lanulosa Villarreal & A.E. Estrada, E.E. 22377.
Verbesina microptera DC., M.S. 585.
Verbesina olsenii B.L. Turner, M.S. 163.
Vernonia greggii A. Gray var. *greggi*, E.E. 21135; M.S. 1377.
Vernonia obtusa (Gleason) S.F. Blake var. *obtusa*, M.S. 1358.
Viguiera cordata (Hook. & Arn.) D´Arcy, M.S. 840.
Wedelia acapulcensis Kunth var. *hispida* (Kunth) Strother, E.E. 21040, 21105, 21253, 21822.
Xanthium strumarium L., E.E. 21035, 21082.
Zinnia peruviana L., E.E. 21045, 21084.
Zinnia juniperifolia (DC.) A. Gray, M.S. 1407.

Basellaceae
Anredera scandens (L.) Moq., E.E. 21484.

Begoniaceae
Begonia gracilis Kunth, E.E. 21114a.
Begonia uniflora S. Watson, E.E. 21114.

Berberidaceae
Berberis eutriphylla (Fedde) C.H. Mull., M.S. 896.
Berberis gracilis Benth, var. *madrensis* Marroq., E.E. 21878.
Berberis trifoliolata Moric., M.S. 621.

Bignoniaceae
Chilopsis linearis (Cav.) Sweet, E.E. 20987, 21832.
Tecoma stans (L.) Juss. ex Kunth, E.E. 21137, 21676.

Boraginaceae
Antiphytum heliotropioides DC., M.S. 1577.
Cordia boissieri A. DC., M.S. 234.
Ehretia anacua (Terán & Berl.) I.M. Johnst., E.E. 21090.
Hackelia leonitis I.M. Johnst., M.S. 293.
Heliotropium angiospermum Murray, E.E. 21218.
Heliotropium torreyi I.M. Johnst., E.E. 21056, 21224.
Lithospermum calycosum (J.F. Macbr.) I.M. Johnst., M.S. 1570.
Omphalodes cardiophylla A. Gray ex Hemsl., E.E. 21873.
Tiquilia canescens (DC.) A.T. Richardson),M.S. 1450.
Tiquilia greggii (Torr. & A. Gray) A.T. Richardson, M.S. 1548.

Brassicaceae
Cardamine auriculata S. Watson, E.E. 21750.
Diplotaxis muralis (L.) DC., E.E. 21701.
Eruca sativa Mill., M.S. 1226.
Erysimum capitatum (Douglas) Greene), E.E. 21759.

Lepidium virginicum L., E.E. 21712; M.S. 1013.
Lesquerella berlandieri S. Watson, E.E. 21716.
Lesquerella lasiocarpa (Hook. ex A. Gray) S. Watson, M.S. 893.
Lesquerella purpurea (A. Gray) S. Watson, E.E. 21779.
Rorippa nasturtium-aquaticum (L.) Hayek, E.E. 21440, 21814.
Sisymbrium auriculatum A. Gray, M.S. 801, 1168.
Sisymbrium irio L., E.E. 21728, 21840.

Cactaceae
Cylindropuntia cholla F.A.C. Weber, M.S. 1314.
Cylindropuntia imbricata (Haw.) F.M. Knuth, M.S. 705, 898.
Cylindropuntia kleiniae (DC.) F.M. Knuth, M.S. 29.
Cylindropuntia leptocaulis (DC.) F.M. Knuth, E.E. 21767.
Echinocactus platyacanthus Link & Otto, M.S. 1242.
Echinocereus parkeri, N.P. Taylor, M.S. 744.
Echinocereus rayonesensis N.P. Taylor, M.S. 746.
Echinocereus pentalophus (DC.) Rumpler, M.S. 716.
Echinocereus stramineus (Engelm.) Rümpler, M.S. 31.
Ferocactus glaucescens (DC.) Britton & Rose, M.S. 1315.
Ferocactus hamatacanthus (Muhl.) Britton & Rose ssp. *sinuatus* (A. Dietr.) N.P. Taylor, E.E. 21766, 66.
Ferocactus pilosus (Galeotti) Werderm., M.S. 1620.
Glandulicactus uncinatus (Galeotti ex Pfeiff.) Backeb., M.S. 1316.
Mammillaria chionocephala J.A. Purpus, M.S. 1445.
Mammillaria formosa Galeotti ex Scheidw ssp. *formosa*, M.S. 1475.
Mammillaria melanocentra Poselg. ssp. *linaresensis* (R. Wolf & F. Wolf) D.R. Hunt, M.S. 1472.
Mammillaria prolifera (Mill.) Haw. ssp. *arachnoidea* (D.R. Hunt) D.R. Hunt, M.S. 1441.
Mammillaria winterae Boed., M.S. 1550.
Opuntia cantabrigensis Lynch, M.S. 679.
Opuntia engelmannii Salm-Dyck ex Engelm., M.S. 655.
Opuntia robusta L.H. Wendl., M.S. 1569.
Opuntia stenopetala Engelm., M.S. 1484.
Opuntia stricta Haw. ssp. *stricta*, M.S. 1473.
Selenicereus spinulosus (DC.) Britton & Rose, E.E. 21482.
Thelocactus tulensis (Poselger) Britton & Rose, M.S. 1446.

Campanulaceae
Lobelia calcarea Wimm., E.E. 21492.
Lobelia cardinalis L. ssp. *graminea* (Lam.) McVaugh, E.E. 21922.
Lobelia ehrenbergii Vatke, M.S. 405.
Lobelia fenestralis Cav., M.S. 418.
Lobelia sublibera S. Watson, E.E. 21132, 21143; M.S. 405, 418.

Cannabaceae
Celtis laevigata Willd., E.E. 21773.
Celtis pallida Torr., E.E. 21770.

Caryophyllaceae
Arenaria oresbia Greenm., M.S. 1557.
Drymaria glandulosa Persl., M.S. 1587.
Drymaria aff. *laxiflora* Benth., E.E. 21734.
Silene laciniata Cav., E.E. 20925.

Celastraceae
Mortonia palmeri Hemsl., E.E. 20926.
Schaefferia cuneifolia A. Gray, M.S. 1229.

Cleomaceae
Polanisia dodecandra (L.) DC., E.E. 21134, 258.

Convolvulaceae
Convolvulus equitans Benth., M.S. 1471.
Cuscuta indecora Choisy, E.E. 21769.
Dichondra argentea Humb. & Bonpl. ex Willd., E.E. 21700.
Dichondra brachypoda Wooton & Standl., E.E. 21699.
Evolvulus alsinoides L. var. *hirticaulis* Torr., E.E. 21066, 21091.
Evolvulus sericeus Sw., E.E. 21205.
Ipomoea capillacea (Kunth) G. Don, M.S. 1096.
Ipomoea cardiophylla A. Gray, M.S. 1443.
Ipomoea coccinea L., E.E. 21208.
Ipomoea jalapa (L.) Pursh, M.S. 1588.
Ipomoea pubescens Lam., M.S. 1557.
Ipomoea purpurea (L.) Roth, M.S. 520.

Crassulaceae
Echeveria turgida Rose, M.S. 1576.
Sedum calcicola B.L. Rob. & Greenm., E.E. 21929.
Sedum greggii Hemsl., M.S. 1564.
Sedum palmeri S. Watson, M.S. 1591.
Sedum wrightii A. Gray, M.S. 811.
Villadia cucullata Rose, M.S. 1330.

Cucurbitaceae
Cucurbita foetidissima Kunth, E.E. 21928.
Cucurbita maxima Duchesne, M.S. 252.
Cucurbita texana (Scheele) A. Gray, M.S. 1590.
Ibervillea lindheimeri (A. Gray) Greene, E.E. 21748.
Melothria pendula L., E.E. 21479.

Ebenaceae
Diospyros texana Scheele, M.S. 704.

Ericaceae
Arbutus xalapensis Kunth, M.S. 258.
Comarostaphylis polifolia (Kunth) Zucc. ex Klotzsch, M.S. 1454.

Euphorbiaceae
Acalypha dioica S. Watson, E.E. 21927.
Acalypha lindheimeri Müll. Arg., E.E. 21131, 21173, 21200, 21740; M.S. 23.
Acalypha monostachya Benth., E.E. 21074; M.S. 1287.
Argythamnia neomexicana Müll. Arg., E.E. 21630, 21657.
Bernardia myricifolia (Scheele) Benth. & Hook., E.E. 21753, 64.
Croton ciliato-glandulifer Ortega, E.E. 21038, 21083, 21515.
Croton cortesianus Kunth, E.E. 21111.
Croton dioicus Cav., M.S. 652.
Croton fruticulosus Engelm. ex Torr., E.E. 21911.
Croton suaveolens Torr., M.S. 243.
Euphorbia antisyphilitica Zucc., M.S. 5, 43a.
Euphorbia campestris Schltdl. & Cham., E.E. 21073.
Euphorbia cinerascens Engelm., E.E. 21030.
Euphorbia dentata Michx., E.E. 21055.
Euphorbia greggii Boiss., E.E. 21068.
Euphorbia hexagona Nutt. ex Spreng., E.E. 21050.
Euphorbia hirta L., E.E. 21099, 21273.
Euphorbia neilmulleri M.C. Johnst., E.E. 2125.
Euphorbia nutans Lag., E.E. 21155.
Euphorbia prostrata Aiton, E.E. 21247, 21265.
Euphorbia schiedeana Mayfield, E.E. 21225, 21269.
Euphorbia villifera Scheele, E.E. 21184.
Jatropha dioica Cerv. var. *graminea* McVaugh, E.E. 21833; M.S. 747.
Phyllanthus polygonoides Spreng., E.E. 21031, 21078, 21660.
Ricinus communis L., M.S. 231.
Tragia nepetifolia Cav., E.E. 21025, 21213, 21258; M.S. 313

Fabaceae
Acacia amentacea DC., M.S. 230.
Acacia berlandieri Benth., E.E. 21609, 21656, 21831.
Acacia coulteri Benth., E.E. 21475, 21673, 21827a, 21870.
Acacia farnesiana (L.) Willd., M.S. 211.
Acacia roemeriana Scheele, E.E. 21856, 36.
Acaciella angustissima (Mill.) Britton & Rose var. *angustissima*, E.E. 21151; M.S. 262, 623.
Amicia zygomeris DC., E.E. 21110.

Astragalus greggii S. Watson, M.S. 1147.
Astragalus hypoleucus S. Schauer, E.E. 21720.
Bauhinia macranthera Benth. ex Hemsl., E.E. 21828.
Brongniartia magnibracteata Schltdl., M.S. 604; M.S. 1346
Caesalpinia mexicana A. Gray, E.E. 21104.
Calliandra eriophylla Benth., M.S. 1444.
Calliandra conferta Benth., M.S. 1559.
Canavalia villosa Benth., M.S. 1522.
Centrosema virginianum (L.) Benth., E.E. 21226.
Cercis canadensis L. var. *mexicana* (Rose) M. Hopkins, M.S. 291.
Chamaecrista greggii (A. Gray) Pollard in A. Heller var. *greggii*, E.E. 21221.
Clitoria mariana L., E.E. 21141, 21185.
Cologania angustifolia Kunth, E.E. 21146.
Cologania broussonetii (Balb.) DC., E.E. 21126, 21150.
Cologania pallida Rose, M.S. 1131.
Coursetia caribaea (Jacq.) Lavin var. *caribaea*, E.E. 21203, 21246, 21821; M.S. 1349, 1531.
Crotalaria incana L., E.E. 21148a.
Crotalaria mollicula Kunth, E.E. 21094, 21148, 21175, 21267.
Crotalaria pumila Ortega, M.S. 1442.
Crotalaria quercetorum Brandegee, M.S. 1485.
Crotalaria rotundifolia Poir. var. *vulgaris* Brandegee, M.S. 1566.
Dalea bicolor Humb. & Bonpl. in Willd. var. *bicolor*, M.S. 932.
Dalea capitata S. Watson var. *lupinocalyx* Barneby, E.E. 21827; M.S. 1195.
Dalea greggii A. Gray, M.S. 1460.
Dalea hospes (Rose) Bullock, E.E. 21116.
Dalea lutea Willd. var. *lutea*, M.S. 901.
Dalea melantha S. Schauer var. *melantha*, M.S. 904.
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Rhynchosia minima (L.) DC., M.S. 276.
Rhynchosia senna Gillies ex Hook. & Arn. var. *angustifolia* (A. Gray) Grear, E.E. 21139; M.S. 1532
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Senna wislizeni H.S. Irwin & Barneby var. *painteri* (Britton & Rose) H.S. Irwin & Barneby, M.S. 659.
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Hedeoma palmeri Hemsl., M.S. 681, 966.
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Leucophyllum frutescens (Berland.) I.M. Johnst., M.S. 1213.

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BOOK REVIEW

David Moore. 2013. **Fungal Biology in the Origin and Emergence of Life.** (ISBN-13: 978-1-107-65277-4, pbk.). Cambridge University Press, 32 Avenue of the Americas, New York, New York 10013-2473, U.S.A. (**Orders:** www.cambridge.org, 1-212-337-5000). \$42.99, 236 pp., 28 b&w illustrations, 2 tables, 6" × 9".

Mycologists will welcome this book! Too often fungi are ignored in discussions about the origin of life as well as their importance to world ecosystems. This book, as the title implies, considers the role of fungi in later eukaryote evolution. Heretofore emphasis on prebiological evolution, protocells, and biofilms led to prokaryotic discussions of the earliest pathways of evolution and mostly ignored the role of fungi. Moreover, the central thesis of this book "… is based on appreciation of the central role of the fungi grade of organization in the evolution of higher organisms."

Chapters 1 and 2 discuss the diversity of present-day fungi in form, function, and biology. Chapter 3 describes the formation of the solar system that gave birth to the Earth and Moon. Chapter 4 highlights the carbon-based molecules present that contributed to the early building blocks of organic compounds necessary for life on Earth. The panspermia hypothesis (extraterrestrial origin of life) is explored in Chapter 5 which is not a viable scientific option for the author. In Chapters 6 to 10 (pages 70–141) much attention is given to the first formation and definition of life on young earth. The reader has to wait more than halfway through the book for Chapter 11 "Toward Eukaryotes." However, one of the more interesting observations is based on the theme "are animals necessary?", especially since humans asking the question are animals. The author argues for a balanced life system: bacteria to begin, green plants as producers, and fungi as decomposers. The bottom line is that Earth could exist without animals and still be balanced. I recommend Chapter 8 "It's life, Jim …" for any general biology student who wants to review the properties of a "living" system: LIFE.

Finally we arrive at the "Rise of the Fungi" in Chapter 12 and the discussion of *Prototaxites*, the largest organism present during the Devonian period (up to 9 meters tall). Recent evidence strongly suggests that this was a giant terrestrial saprotrophic fungus with hyphae and spores and was the dominant living form on this ancient landscape. Imagine a fungus the size of a small tree that lasts for 40 million years about 420 million years ago. Add to this the incredible diversity of fungal forms—chytrids, sexual reproductive stages, Ascomycetes, and more, beautifully preserved, found in the Devonian Rhynie Chert of northern Scotland, mostly by Tom Taylor and coworkers at the University of Kansas—and one appreciates that fungi have played a significant role in the evolution of life on planet earth for a long time. Far longer than once thought! More discussion here includes the importance of sclerotia (fungal mass of hyphae), free cell formation, filamentous growth, cell fusion, and septum (cross wall) formation that are all found in fossil and extant fungi.

This is a must-read, fascinating book for anyone interested in evolution or fungi. Some chapters are highly technical, but others are easily understood by a nonscientist. Table 1 gives a geological and biological chronicle of events on Earth from 2500 million years ago to present day. References are cited and occupy pages 204–218, many of more recent origin. There is no glossary which sometimes complicates some of the terminology, but this is a minor distraction. The Index (pages 219–231) is a convenient shortcut to specific topics.

Every scientist interested in the broad topic of evolution of life on Earth should have this book on their bookshelf. It is affordable, readable, understandable, and easily could be used in evolution-based seminars or as selected reading for general biology courses.—*Harold Keller, PhD, Research Associate, Botanical Research Institute of Texas, Fort Worth, Texas, U.S.A.*

NUEVOS REGISTROS DE CACTACEAE Y SOLANACEAE PARA EL ESTADO DE GUANAJUATO, MÉXICO

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RESUMEN

Se presentan localidades nuevas de distribución geográfica de tres especies de Cactaceae y Solanaceae de México. *Mammillaria mathildae*, una especie microendémica conocida de pequeñas poblaciones en los alrededores de la ciudad capital del estado de Querétaro y *Physalis longiloba* y *P. waterfallii*, especies endémicas conocidas solamente del estado de Jalisco en el Occidente de México y de Michoacán, se registran por primera vez en el estado de Guanajuato, en la región del Bajío mexicano. Las tres especies amplían su distribución a nivel regional ya que solamente se conocían de los estados de Querétaro, Jalisco y Michoacán.

PALABRAS CLAVE: Cactaceae, Guanajuato, Solanaceae, nuevos registros, México

ABSTRACT

New state records for one species of Cactaceae and two species of Solanaceae from México are presented. *Mammillaria mathildae*, a narrow endemic species known only from limited populations around the capital city of Querétaro, and *Physalis longiloba* and *P. waterfallii* are endemic species known only from Jalisco in western México and Michoacán, are recorded for the first time from Guanajuato. The three species were previously known only from the states of Jalisco, Michoacán, and Querétaro.

KEY WORDS: Cactaceae, Guanajuato, Solanaceae, new records, México

INTRODUCCIÓN

En años recientes, el conocimiento sobre la riqueza florística del estado de Guanajuato ha mejorado notablemente, sin embargo, esta entidad aún no cuenta con un inventario completo de su flora, pues los estudios hasta ahora son parciales e incompletos. Las estimaciones más recientes señalan que el estado de Guanajuato alberga 182 familias, 904 géneros y 2774 especies de plantas vasculares (Zamudio & Galván 2011). De esta riqueza solo 35 especies están registradas en la Norma Oficial Mexicana, NOM-ECOL-059-2001 (Anónimo 2002) como amenazadas o con protección especial y una en peligro de extinción, de las cuales 31 son endémicas de México y tan solo 26 son exclusivas de Guanajuato y la mayoría conocidas solamente de la localidad tipo. Considerando el alto deterioro de la vegetación del estado y que muchas especies están sometidas a grandes presiones de recolecta con fines ornamentales, el bajo número de especies protegidas resulta preocupante. La recolecta y revisión de material botánico como producto de estudios florísticos siguen aportando información notable que incrementa el conocimiento de la flora mexicana. Así, las cifras hasta ahora conocidas para el estado de Guanajuato se siguen incrementando, pues investigaciones recientes siguen revelando la existencia de plantas que no se habían registrado anteriormente para la entidad y no sería raro el descubrimiento de plantas que aún no han sido descritas. Durante el desarrollo de estudios florísticos en el Área Natural Protegida "Sierra de Lobos" del Estado de Guanajuato, en el Bajío mexicano, destaca el hallazgo de localidades no registradas previamente para tres especies de Cactaceae y Solanaceae. Las recolectas recientes que provienen de bosque de encino en el Municipio San Felipe, expande el área de distribución conocida de *Mammillaria mathildae* Kraehenb. y Krainz siendo éste el primer registro para el estado de Guanajuato. Especímenes de recolectas recientes en la ex-Hacienda San Juan de Otates, en el Municipio de León, extienden el área de distribución de *Physalis longiloba* Vargas, M. Martínez & Dávila (Cactaceae), taxón microendémico conocido solamente de la Sierra de Manantlán

en el estado de Jalisco y es un registro nuevo para Guanajuato. Asimismo, especímenes procedentes de El Capulín, Municipio San Felipe extienden los límites de distribución de *Physalis waterfallii* Vargas, M. Martínez y Dávila, un taxón de distribución más amplia pero endémico de los estados de Jalisco y Michoacán, siendo éste el primer registro para el estado de Guanajuato.

MÉTODOS

Los especímenes de los taxa citados provienen de recolectas recientes que se hicieron en el Área Natural Protegida Sierra de Lobos, en el estado de Guanajuato, en la región del Bajío mexicano. Estos ejemplares se estudiaron detalladamente y la determinación de la identidad de las especies se hizo mediante claves y descripciones de distintas obras florísticas (Bravo-Hollis & Sánchez-Mejorada 1991; Glass 1998; Scheinvar 2004; Vargas et al. 1999, 2001, 2003). Los ejemplares botánicos están depositados en el herbario QMEX.

RESULTADOS Y DISCUSIÓN

Las recolectas de material botánico en Sierra de Lobos, Guanajuato son escasas, especialmente en las áreas montañosas y de lomeríos. Esto, debido tal vez a lo inaccesible del terreno y porque buena parte del área es propiedad privada, lo que provoca que sean pocos los recolectores que se internan en esos lugares para hacer estudios florísticos.

Algunos especímenes de recolectas recientes se identificaron como *Mammillaria mathildae* (Cactaceae), *Physalis longiloba* (Solanaceae) y *Physalis waterfallii* (Solanaceae) provenientes del bosque templado de *Quercus* de los municipios San Felipe y León respectivamente, en el estado de Guanajuato. Las tres localidades amplían la distribución conocida de estas especies y representan el primer registro para el estado.

Mammillaria mathildae Kraehenb. y Krainz es una especie microendémica que habita en lugares secos del bosque tropical caducifolio. Actualmente solo están reconocidas y documentadas dos poblaciones de esta especie, la localidad tipo al sureste de la capital del estado de Querétaro, en La Cañada, municipio El Marqués (Bravo-Hollis & Sánchez-Mejorada 1991; Glass 1998; Hernández & Sánchez 2002) y la segunda al noroeste de la capital queretana en Los Cajones, Provincia Juriquilla, municipio de Querétaro (Hernández & Sánchez 2002). Esta especie habita áreas perturbadas del bosque tropical caducifolio, entre 1850 y 2030 m de altitud, donde destacan especies como:

Bursera fagaroides (HBK) Engl.
Bursera palmeri S. Wats.
Calliandra eryophylla Benth.
Ceiba aesculifolia Britt. y Baker
Lysiloma microphylla Irwin y Barneby
Myrtillocactus geometrizans (Mart.) Cons.
Opuntia spp. Mill.
Senna polyanta (Collad.) Irwin y Barneby
Stenocereus dumortieri (Scheidw) Buxb.

En la localidad La Cañada también están presentes especies indicadoras de fases sucesionales que muestran el deterioro de la vegetación original (Zamudio et al. 1992; Hernández & Sánchez 2002), tales como:

Acacia farnesiana (L.) Willd.
Karwinskia humboldtiana (Roem. y Schult.) Zucc.
Ipomoea murucoides Roem. y Schult.

Mammillaria mathildae Kraehenb. y Krainz es una especie catalogada como vulnerable por la IUCN (Walter & Guillett 1998) y amenazada por la NOM-059-ECOL-2001 (Anónimo 2002). Sin embargo, estudios detallados de sus poblaciones (Hernández & Sánchez 2002) la señalan como “en peligro de extinción”. El hábitat conocido en la localidad tipo de esta especie se reduce a poco más de una hectárea y los agentes de disturbio que afectan considerablemente su población son la ganadería no planeada, la extracción de leña, la extracción de cantera, la extracción de plantas con fines ornamentales y la presencia de tiraderos de basura y de escombro clandestinos (Cabrera-Luna & Gómez-Sánchez 2005).

La localidad del reciente espécimen de *Mammillaria mathildae* Kraehenb. y Krainz (Fig. 1) es nueva para el estado de Guanajuato y amplía su distribución y su límite altitudinal. Esta especie ha estado sometida a

Fig. 1. A la izquierda *Mammillaria mathildae* Kraehenb. y Krainz (datos de recolecta en resguardo) creciendo en bosque de encino, municipio San Felipe, Guanajuato. Al centro, *Physalis longiloba* Vargas, M. Martínez & Dávila (*A. González et al., 733-777* QMEX) habitando en bosque de encino, ex Hacienda San Juan de Otates, municipio de León, Guanajuato, 2641 msnm. A la derecha, *Physalis waterfallii* Vargas, M. Martínez & Dávila (*A. González et al. 159*, QMEX) en bosque de encino, El Capulín, municipio San Felipe, Guanajuato, 2385 msnm.

presión de recolecta por su potencial ornamental por lo que los datos precisos de esta localidad se omiten aquí para evitar un posible saqueo de individuos. No obstante, cuando sea de interés, la información podrá solicitársele al primer autor. Lo notable de esta nueva localidad es que alberga un bosque templado de *Quercus* L., con una altitud sobre los casi 2300 m, que sale de los límites conocidos hasta ahora, cerca de los paralelos 20° Lat N, 100° Long W y 1850 msnm en los alrededores de la ciudad de Querétaro. Esta nueva localidad es un complejo de lomeríos con bosque de encino compuesto principalmente por:

Quercus eduardii Trel.
Quercus grisea Liebm.
Quercus resinosa Liebm.
Quercus rugosa Née

En el estrato herbáceo, es común la presencia de especies como:

Dasylirion sp. Zucc.
Loeselia coerulea (Cav.) G. Don
Mimosa sp. L.
Physalis patula Miller
Tagetes sp. L.

La presencia de *Mammillaria mathildae* Kraehenb. y Krainz es más frecuente en pequeñas áreas abiertas por la perturbación, dentro del encinar. Este hallazgo reciente tal vez representa el límite de distribución de la especie, que va desde los alrededores de la ciudad de Querétaro llegando hasta San Felipe, Guanajuato. Este taxón sigue un patrón de vegetación en el que se alterna el bosque tropical caducifolio, el bosque espinoso y el matorral xerófilo (como ocurre en la localidad tipo) llegando al bosque de encino. Los registros de esta especie aumentan a medida que se hacen más exploraciones y esto amplía su distribución. Así entonces, una exploración exhaustiva y una nueva evaluación de las poblaciones de *Mammillaria mathildae*, aunque pequeñas, podrían modificar su estatus de conservación hasta ahora conocido.

Physalis longiloba Vargas, M. Martínez y Dávila es una especie endémica conocida, hasta ahora, solamente de la Sierra de Manantlán, Reserva de la Biósfera, en el estado de Jalisco al occidente de México. Crece de manera abundante en lomeríos, en áreas abiertas o senderos del bosque mesófilo de montaña y de bosque de pino-encino muy húmedo, entre las coordenadas 19°35'55" Lat N y 104°12'35" Long W, a 2100 msnm. *Physalis longiloba* es superficialmente similar a *P. lignescens* Waterf. y se puede confundir con *P. gracilis* Miers (Vargas et al. 2001, 2003). Sin embargo, el cáliz de la flor de 1.5 mm de longitud con largos lóbulos acuminados de hasta 9 mm y el cáliz cuando frutece con 5 ángulos, en los ejemplares recientes, mostraron claramente su identidad.

Las recolectas recientes de *Physalis longiloba* (México. Guanajuato, Ex Hacienda San Juan de Otates, mu-

nicipio de León, 21°12'58" Lat N, 101°32'10" Long W, 2641 m de altitud, *A. González et al. 733-737,* QMEX) son nuevos registros para el estado de Guanajuato y amplían el área de distribución conocida para este taxón al Bajío mexicano, región situada al noroeste de la distribución conocida hasta ahora. En esta localidad, *Physalis longiloba* (Fig. 1) habita en un bosque de encino dominado por *Quercus rugosa* Née, *Q. eduardii* Trel. y *Q. potosina* Trel. En el estrato herbáceo destacan especies como:

Aegopogon cenchroides Humb. & Bonpl. ex Willd.
Erodium cicutarium (L.) L'Hér. ex Aiton
Eryngium carlinae F. Delaroche
Hilaria cenchroides Kunth
Loeselia coerulea (Cav.) G. Don
Physalis sordida Fernald
Physalis chenopodifolia Lam.
Piptochaetium brevicalyx (E. Fourn.) Ricker
Salvia sp L.

Aunque esta nueva localidad amplía su distribución geográfica, *P. longiloba* sigue representando un microendemismo, con presencia únicamente en la Sierra de Manantlán al sur del estado de Jalisco y la nueva localidad en el municipio de León, Guanajuato.

Physalis waterfallii Vargas, M. Martínez y Dávila es una especie de distribución más amplia pero endémica del estado de Jalisco y de una localidad al norte de Michoacán. Habita en bosques de pino-encino y mesófilo de montaña, también es común localizarla en claros o pendientes, a veces asociada a cultivos y con frecuencia a la sombra de encinos (Vargas *et al.* 1999, 2003), a altitudes entre los 1700 y 2450 msnm. Esta especie se reconoce fácilmente en campo porque sus lóbulos calicinos en la flor y en el fruto son largos, alcanzan hasta 1 cm de longitud y exceden a los botones florales.

Los especímenes recientes de *Physalis waterfallii* (México. Guanajuato, El Capulín, municipio San Felipe, 21°22'26.1" Lat N, 101°18'54.66" Long W, 2385 msnm, *A. González et al. 159,* QMEX) son registros nuevos para el estado de Guanajuato. Esta localidad es una área comunal donde se permite el aprovechamiento de sus recursos naturales y, como Unidad de Manejo para la Conservación de la Vida Silvestre (UMA), está registrada ante la Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT, 2012) con el código SEMARNAT-UMA-Ext-0019-Gto. En este sitio *P. waterfallii* (Fig. 1) habita un bosque de encino de *Quercus rugosa, Q. eduardii y Q. potosina.* En el estrato herbáceo destacan especies como:

Aegopogon cenchroides Humb. & Bonpl. ex Willd.
Bouteloua gracilis (Kunth) Lag. ex Griffiths
Bouteloua hirsuta Lag.
Castilleja arvensis Schltdl. & Cham.
Dalea bicolor Humb. & Bonpl. ex Willd.
Desmodium aparines (Link) DC.
Desmodium grahamii A. Gray
Echinopepon milleflorus Naud.
Loeselia mexicana (Lam.) Brand
Pellaea cordifolia (Sessé & Moc.) A.R. Sm.
Pellaea ternifolia (Cav.) Link
Physalis hastatula Waterf,
Piptochaetium fimbriatum (Kunth) Hitchc.
Salvia patens Cav.
Silene laciniata Cav.
Stachys coccinea Ortega
Tagetes lunulata Ortega

Con este nuevo hallazgo, se observa que *Physalis waterfallii* sigue la presencia de los bosques húmedos de encino del Occidente al Bajío mexicano. No obstante, esta especie se mantiene con una distribución restringida a la parte centro-sur del estado de Jalisco, una localidad en el Municipio de Zinapécuaro, al norte del estado de Michoacán y la nueva localidad en El Capulín, municipio San Felipe, al noroeste del estado de Guanajuato, formando un continuo entre los tres estados.

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BOOK REVIEW

Peter Roberts and Shelley Evans. 2011. **The Book of Fungi: A Life-size Guide to Six Hundred Species from Around the World.** (ISBN-13: 978-0-226-721172-0, cloth, alk. paper). University of Chicago Press, 1427 E. 60th Street, Chicago, Illinois 60637, U.S.A. (**Orders:** Customer Service, Chicago Distribution Center, 11030 South Langley Avenue, Chicago, Ilinois 60628, 1-800-621-2736 (USA and Canada), 1-773-702-7000 (International), orders@press.uchicago.edu). $55.00, 656 pp., 2000 color plates, 7.5" × 11" × 2".

This is a big, weighty book illustrated with life-size color images of fungal fruit bodies that appear in ones, twos, or small groups but not in natural habitats. Each fungal species is given one full page that has the some standardized information: for example *Agaricus campestris* (Field Mushroom) starts with a brief description including habitats such as lawns, parks, pastures, and other areas of undisturbed short grass. Another section, Similar Species, notes species that appear morphologically similar but with a brief description of the differences. At the top fourth of the page is a world geographical map with the family, distribution, habitat, association, growth form, abundance, spore color, and edibility. The height and diameter of fruit bodies is given in an inset.

The beginning sections include a Foreword; Introduction; What are Fungi?; Plant and Animal Partners; Natural Recyclers; Pest and Parasites; Food, Folklore and Medicine; Distribution and Conservation; Collecting and Identifying Fungi; and Guide to the Fungi. The authors state, "This book is not a field guide …" and therefore keys to families and species are lacking. A picture guide is provided that highlights groups—e.g., "Agarics" are defined as having "fleshy fruit bodies, cap with or without stem, gills underneath cap," and this is the first group discussed, described, and illustrated beginning on page 31 and ending on page 323, representing 292 species or almost half of the 600 species. Next are the boletes, or fleshy pore fungi, on pages 325–361. The wood rotters are represented by the brackets, crusts, and jelly fungi on pages 362–461. Tooth fungi, chanterelles, clubs, and corals are a mixed bag of very different spore-bearing surfaces with little to argue for this grouping on pages 462–505. The puffballs and earthstars, bird's nests, and stinkhorns conclude the Basidiomycetes on pages 507–547. The Ascomycetes begin with the cup fungi, morels, truffles, flask fungi, and lichens on pages 549–641.

The text is written in nontechnical prose, readily understandable by the lay public, but a short 2-page Glossary of terms also aids the reader. Supplementary information is included in the six following sections: Resources for further reading and general interest, The Classification of Fungi, Index by Common Name, and Index by Scientific Name. Some of the common names applied here are clever and new, for example, Beansprout Fungus (*Conocybe deliquescens*), Green Skinhead (*Cortinarius austrovenetus*), and Collard Parachute (*Marasmius rotula*) to mention a few.

This book is too bulky and heavy to carry into the field and therefore has limited value other than as a coffee table display that highlights the diversity of fungi in color and form. Some species can be identified by picture keying. Many mushroom books are similar in content especially in the introductory sections. The price is a bargain for a book this size containing color illustrations.—*Harold W. Keller, PhD, Research Associate, Botanical Research Institute of Texas, Fort Worth, Texas 76102, U.S.A.*

SEDUM SALVADORENSE (CRASSULACEAE), UNA ESPECIE ENDÉMICA Y RARA REDESCUBIERTA PARA LA FLORA DE EL SALVADOR

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RESUMEN

Se describe *Sedum salvadorense*, como ocurre en la localidad típica, y se presentan por primera vez fotografías de plantas vivas de esta especie, después de 90 años de haberse publicado el descubrimiento por colectas del botánico Paul C. Standley en la Sierra de Apaneca, Ahuachapán (zona occidental de El Salvador) en la expedición realizada en enero de 1922 y considerada extinta ya que desde entonces no se había reportado ni en la zona original de colecta ni en otros lugares. Ahora con dos nuevas localidades, representa un redescubrimiento para la flora salvadoreña. Esta especie se ubica en hábitats muy específicos de áreas no perturbadas y crece sobre rocas en acantilados; habiendo escasa información de la misma. En el país *S. salvadorense*, es la única especie del género; muy rara y poco estudiada en términos ecológicos, fenológicos y geográficos.

PALABRAS CLAVE: *Sedum*, extinta, rara, redescubrimiento, Ahuachapán, Crassulaceae, El Salvador

ABSTRACT

Sedum salvadorense is described from its native habitat and locality and photographs of live plants are presented for the first time, 90 years after the published discovery of collections by Paul C. Standley in the Apaneca, Ahuachapán (western El Salvador) in an expedition from January 1922. The absence of reports from either the original collection locality or anywhere else suggested that the species was extinct. We present two new collection localities, representing a rediscovery for the Flora of El Salvador. This species occurs in very specific habitats in undisturbed areas, and grows on cliff rocks. *S. salvadorense* is very rare and poorly studied from ecological, phenological and geological perspectives and represents the only species of the genus occurring in El Salvador.

KEY WORDS: *Sedum*, extinct, rare, rediscovery, Ahuachapán, Crassulaceae, El Salvador

INTRODUCCIÓN

La familia Crassulaceae agrupa de 1,400 a 1,500 especies y 34–35 géneros. Son plantas perennes o rara vez anuales o bianuales. Se caracterizan por tener generalmente hojas y tallos suculentos y flores hermafroditas, actinomorfas, a menudo pentámeras, con un ovario súpero, carpelos libres y dehiscentes con una escama nectarífera en la base de cada uno. El metabolismo de muchas especies es del tipo del ácido crasuláceo (Thiede & Eggli 2007). Las especies de esta familia tienen una distribución casi cosmopolita con prominentes centros de diversidad en México, Sudáfrica, Este de Asia y la cuenca del Mediterráneo; prosperando generalmente en zonas montañosas sobre sustratos rocosos. Unos pocos representantes son epífitos o acuáticos (Mort & Mori 2004). En los trópicos, las especies están confinadas a las regiones de montaña (Standley & Steyermark 1946) por su follaje colorido y suculento, muchas son ampliamente cultivadas como plantas ornamentales.

Thorne y Reveal (2007) propusieron el reconocimiento de únicamente dos subfamilias: Crassuloideae y Sempervivoideae; esta última, contiene la mayor diversidad taxonómica, incluyendo aproximadamente 980 especies y 28 géneros y ha sido subdividida en cinco tribus por Thiede y Eggli (2007). Sedeae, la más grande de estas tribus, comprende aproximadamente 640 especies incluidas en dos grupos que no han sido aún nombrados formalmente: el clado *Leucosedum* y el clado *Acre* (Carrillo 2009), con cerca de 530 especies (una tercera parte de la diversidad total de la familia), incluye a los representantes de *Sedum* (subgénero *Sedum*). El problema más complicado que enfrenta la sistemática de la familia Crassulaceae es la parafilia de *Sedum* (Carrillo 2009),

siendo un género muy variable y sus límites taxonómicos no se han resuelto todavía ('t Hart & Bleij 2003). El género *Sedum* L., tiene distribución cosmopolita; sin embargo, la mayoría de las especies crecen mejor en las zonas templadas del Hemisferio Norte y comprende cerca de 420 especies. Alrededor de 170 especies crecen en el Continente Americano ('t Hart & Bleij 2003) y en El Salvador, *S. salvadorense* es la única especie del género.

El redescubrimiento

Durante la expedición del botánico Paul C. Standley a El Salvador, en los meses de diciembre de 1921 y mayo de 1922, específicamente en el occidente del país (Ahuachapán) se encontró con una colonia de especies del género *Sedum* en la Finca Colima. Standley relata que estas plantas estaban "algo marchitas como resultado de la larga estación seca (17–19 enero de 1922)." Sin embargo, afirmó en aquel tiempo que esta especie se distinguía claramente de otras reportadas del centro de los Estados Unidos o de México. Es así como publicó en el *Journal of the Washington Academy of Sciences* en 1923 la especie *Sedum salvadorense*. El ejemplar tipo se encuentra depositado en United States National Herbarium (US) con el número 1,136,003.

Durante los recorridos realizados por medio del Proyecto "Mejor Manejo y Conservación de Cuencas Hidrográficas Críticas" (MMCCHC), dentro del Parque Nacional El Imposible, al occidente del país en los meses de diciembre de 2007 y enero 2008, se encontraron plantas sobre rocas y materia orgánica que parecían ser del género *Echeveria*, sin embargo después de un análisis más detallado se llegó a la conclusión que las plantas fotografiadas y encontradas en esos viajes eran colonias (individuos) que pertenecían a la rara y endémica especie *Sedum salvadorense*. Antes de realizar estas colectas, sólo se conocía el ejemplar tipo por lo cual se consideraba extinta. Ahora se presenta en este artículo como un redescubrimiento colonias de especies en dos lugares dentro del área del Parque Nacional El Imposible, y también se reportan las primeras fotografías de la especie (en su hábitat y cultivadas) después de 90 años de su publicación.

Sedum

Desde su creación por Linnaeus, *Sedum* ha tenido límites difusos y ha sido difícil de circunscribir basada en caracteres morfológicos. Los análisis filogenéticos han demostrado que el género es parafilético y que ha sido definido por atributos plesiomórficos. Dilucidar los límites y las relaciones de *Sedum* es, para algunos autores, uno de los principales retos en la sistemática de las Crassulaceae. Por lo tanto, es probable que en el futuro *Sedum* sea segregado en varios géneros. Debido a la escasez del material y al desconocimiento de sus características morfológicas y moleculares; *S. salvadorense* no ha sido analizada filogenéticamente, pero es probable que pertenezca al subgénero *Sedum* donde está la mayor diversidad de especies.

Mientras algunas especies parecen ser bastante estables en lo morfológico, otras, por el contrario, pueden variar grandemente, especialmente en lo que se refiere al indumento y porte entre otros que hace que alguna de sus formas sean difícilmente reconocibles como pertenecientes al mismo taxón (Castroviejo & Calvo 1981). Por tal razón, se describe en este artículo a la especie tal y como ocurre actualmente en la localidad típica, tomando para ello medidas tanto de plantas en el campo como fuera de su hábitat (cultivadas).

DESCRIPCIÓN DE LA ESPECIE

Sedum salvadorense Standl., J. Washington Acad. Sci. 13:438. 1923. (**Fig. 1**). Tipo: El Salvador. Departamento de Ahuachapán: collected on a rock in forest, Finca Colima, Sierra de Apaneca, 17–19 Jan 1922, *Standley 20143* (holotipo: US-Imagen!).

Son plantas perennes, con tallos sufructicosos, de unos 4–20 cm de altura y 2–6 mm de grueso, granular-papiloso de arriba; pocas hojas, alternas, estrechamente espatuladas-oblanceoladas, de 2–9 cm de largo a 0.5–2 cm de ancho, ápice obtuso o redondeado, reducido abajo en un pecíolo ancho, plano, delgado y flácido, verde, las jóvenes granular papiloso; una densa inflorescencia de cima de unos 2 cm. de ancho y 5 cm. de largo, con hasta 15 flores de color blanco-amarillento. Sépalos 5 iguales y carnosos, verde-claro lustroso, lisos de 1cm de largo y 3 mm de ancho. Los pétalos 5 iguales, blanco traslúcido tornándose muy levemente rosáceo con la edad, de 1 cm de largo y 2–4 mm de ancho y borde entero con 10 estambres de 5mm de largo y 0.5 mm de ancho. Las brácteas pequeñas, lineal u oblanceoladas, papilosas, los pedicelos delgados, de 2–3 mm de largo, sépalos linear-oblongos, de 4–4.5 mm de largo, reducido a un ápice romo; pétalos de color blanco, oblongo-ovados,

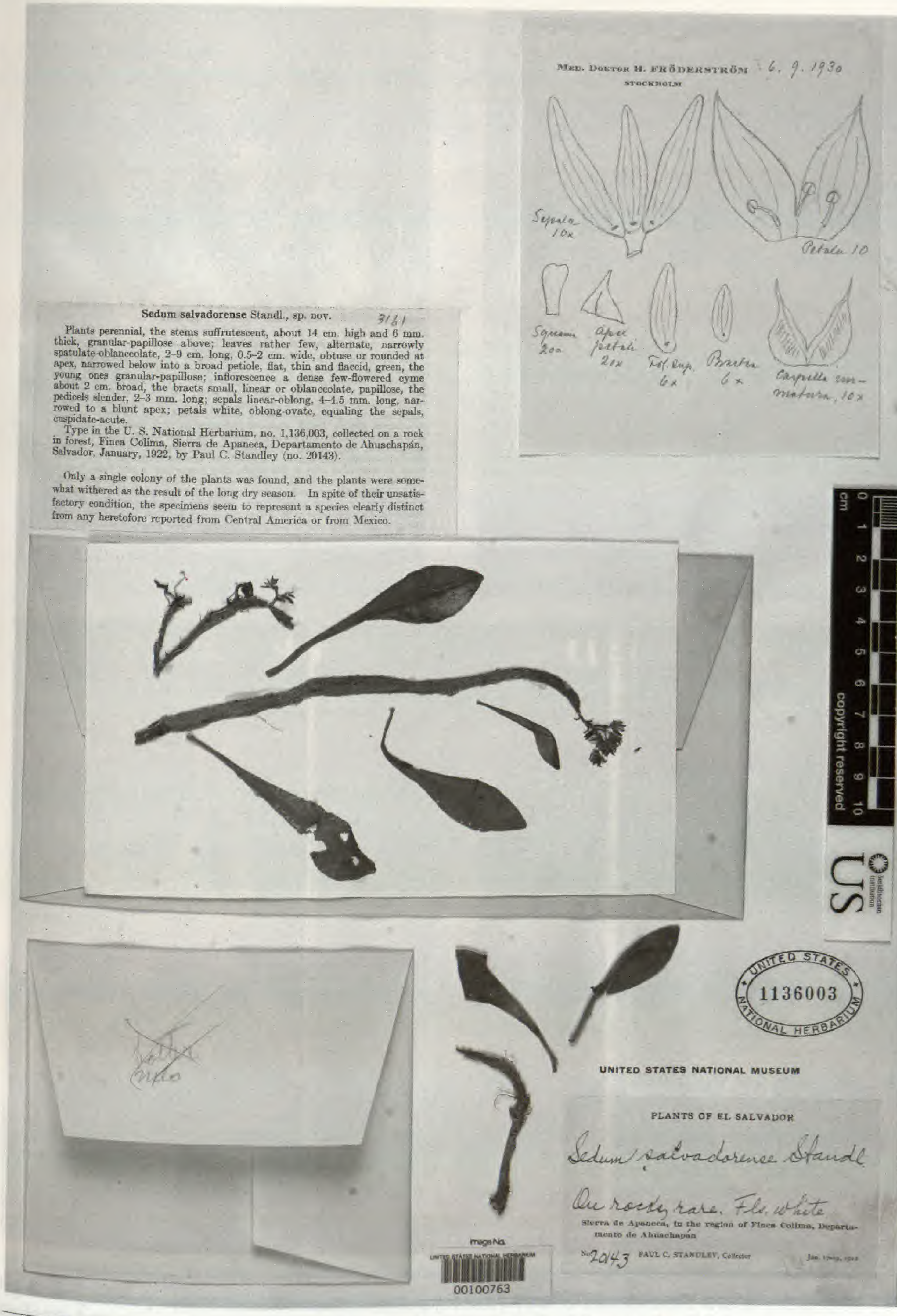

Fig. 1. Imagen tipo de *Sedum salvadorense* Standl. depositada en el US National Herbarium en 1922.

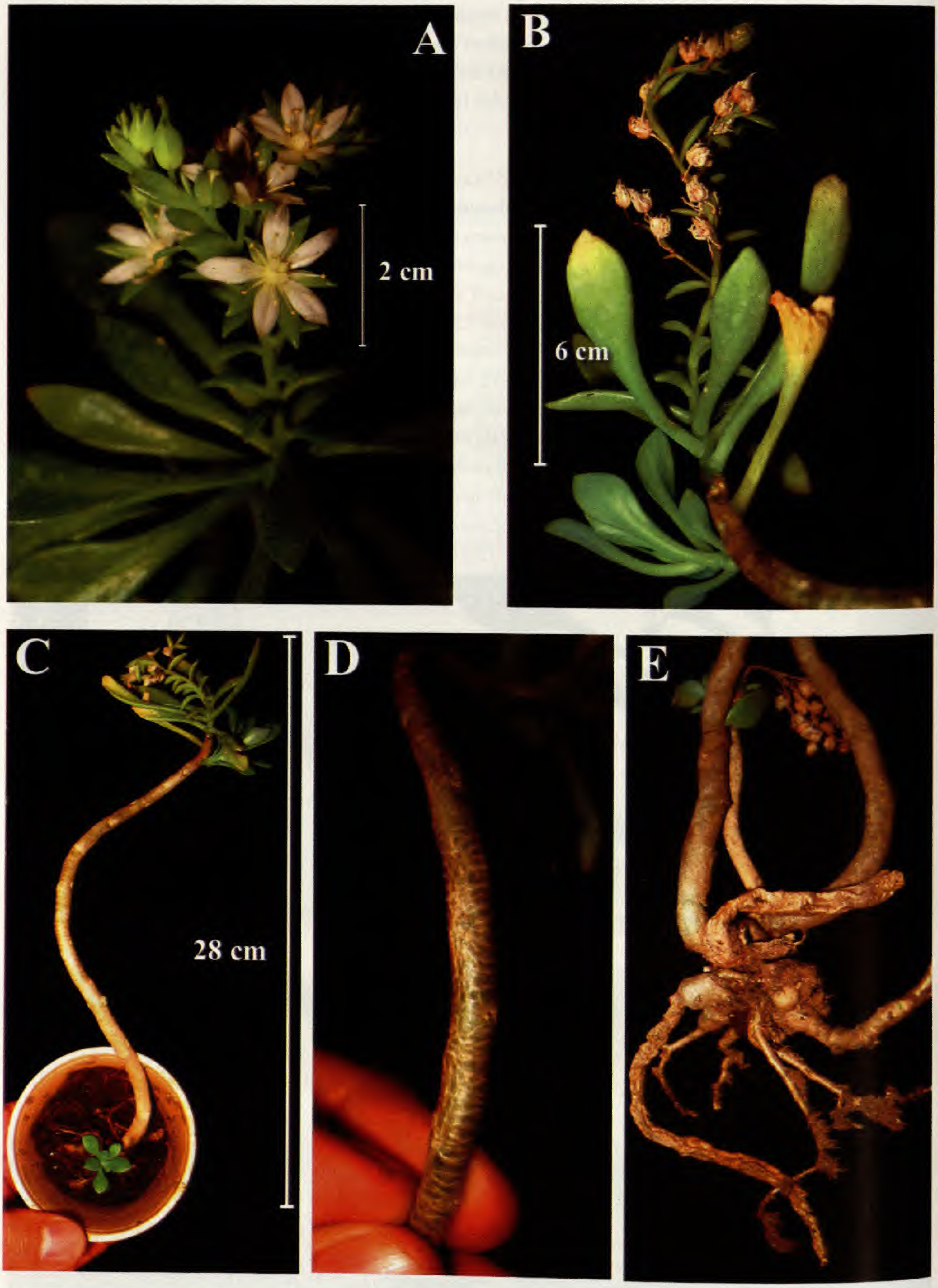

Fig. 2. *Sedum salvadorense* Standl. Plantas cultivadas. **A.** Flores; **B.** Detalle de hojas nuevas e inflorescencia seca; **C.** Detalle de planta completa con hojas nuevas en la base de la raíz; **D.** Tallos sufructicosos; **E.** Detalle de raíz tuberosa. Fotos: Frank Sullyvan Cardoza.

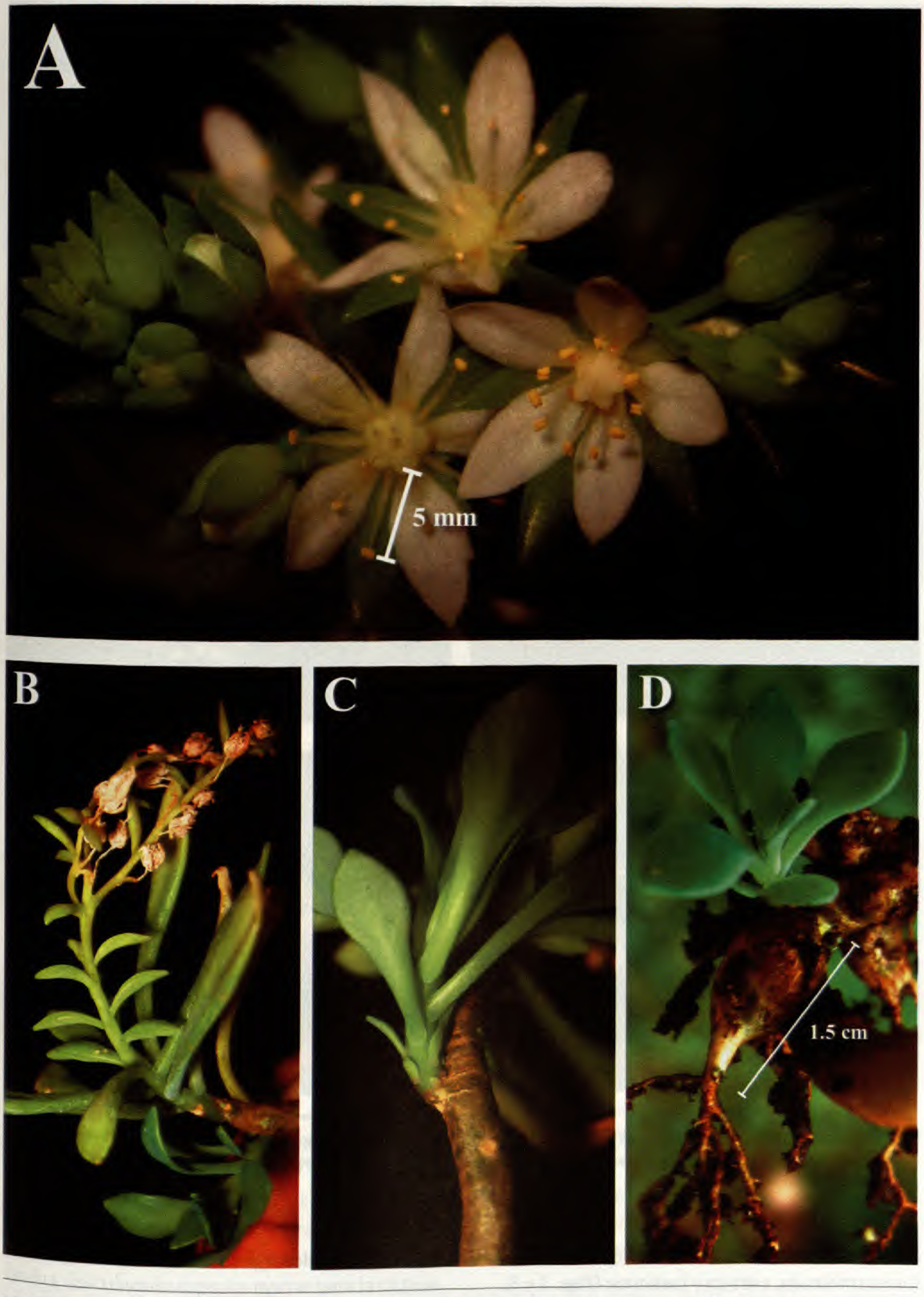

FIG. 3. *Sedum salvadorense* Standl. Plantas cultivadas. **A.** Detalle de flores y botones; **B.** Detalle de inflorescencia seca; **C.** Detalle de hojas nuevas en la base del tallo; **D.** Detalle de raíz tuberosa turbinada. Fotos: Frank Sullyvan Cardoza.

Fig. 4. *Sedum salvadorense* Standl. Plantas en su hábitat. **A.** Rocas basálticas con materia orgánica; **B.** Detalle de plantas jóvenes y secas; **C.** Planta completa con hojas jóvenes; **D.** Detalle de inflorescencia; **E.** Crecimiento sobre materia orgánica; **F.** Planta con hojas secas y flores con botones. Fotos: Frank Sullyvan Cardoza.

igualando los sépalos, cuspidado-agudo. Raíz tuberosa de 0.9–1.5 cm de largo y 0.4–0.6 mm de ancho con forma turbinada, esférica y fusiforme (Figs. 2 y 3).

Hábitat.—Crece sobre rocas verticales basálticas (acantilados) en colinas pedregosas, pequeños cauces de agua o riachuelos con vegetación riparia en el bosque tropical latifoliado semideciduo submontano, bien drenado entre los 720 hasta 1,130 msnm (Figs. 4 y 5). En la localidad tipo se observaron creciendo en el estrato

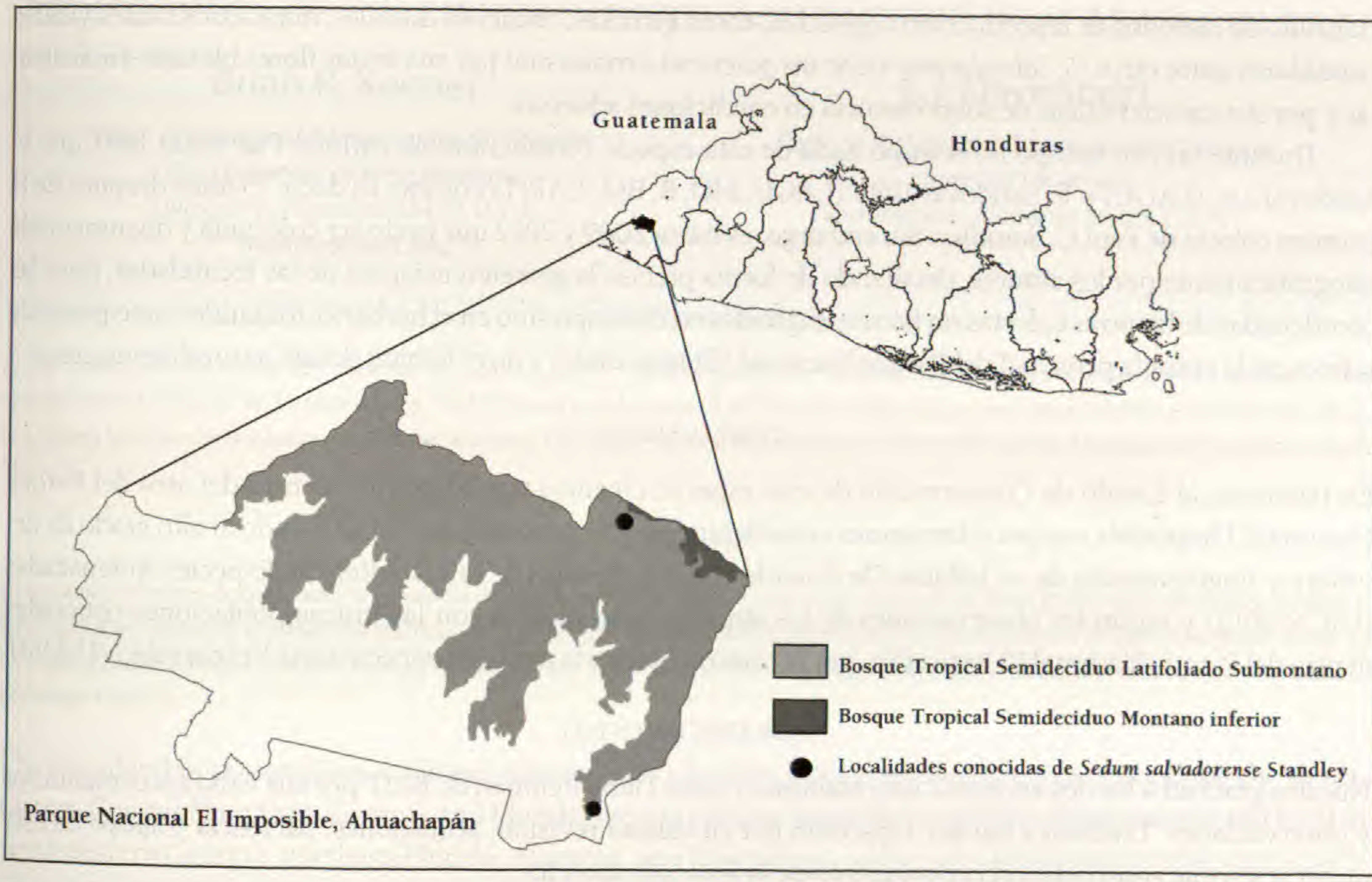

Fig. 5. Distribución geográfica y localidades dentro del Parque Nacional El Imposible de *Sedum salvadorense* Standl.

arbóreo *Garcinia intermedia* (chaparrón), *Brosimum alicastrum* (ujushte), *Calophyllum brasiliense* (varillo), *Swartzia simplex* (naranjillo) y otras. En el estrato arbustivo existen *Hirtella racemosa*, varias especies de *Psychotria* y algunas Nictagináceas muy raras como *Boldoa purpurascens*, *Pleuropetalum sprucei* y *Pisonia donnellsmithii*. En el estrato herbáceo son raras las gramíneas y ciperáceas pero hay una gran diversidad de los géneros *Justicia*, *Ruellia* y *Blechum*. Abundan también *Geophila repens* y alguna piperáceas. Hay algunas palmas del género *Chamaedorea*, algunas commelináceas y orquídeas terrestres de los géneros *Sacoila*, *Corymborkis*, *Tropidia*, *Habenaria* y *Malaxis*. La especie *S. salvadorense* crece específicamente en los lugares más secos, afloramientos rocosos y paredones, en donde es común encontrar densas agrupaciones de *Chusquea coronalis* (bambú de peña), algunos arbustos espinosos de mimosáceas, mientras que en los paredones y barrancos más húmedos se pueden encontrar helechos pequeños y ocasionalmente algunos arborescentes como *Cyathea costaricensis* (MARN 2012).

Fenología.—Florece y fructifica de diciembre a febrero.

Material examinado:—**EL SALVADOR. Ahuachapán:** Municipio de San Francisco Menéndez, Río El Naranjo, creciendo en vegetación riparia y vegetación circundante a la selva mediana subcaducifolia a 720 msnm, Coordenadas 13°49'02"N y 089°54'48"W, 12 ene 2008, *J.L. Linares y F.S.Cardoza 13304* (MEXU). **Ahuachapán:** Municipio de San Francisco Menéndez, Localidad: Montaña "El Orquideario", en vegetación de selva mediana subperennifolia y vegetación secundaria derivada a 1,130 msnm, Coordenadas 13°51'13"N y 089°55'11"W, 27 dic 2007, *J.L. Linares y F.S.Cardoza 13040* (MEXU).

Etimología.—*Sedum* es el nombre de diversas crasuláceas. El epíteto de la especie fue dedicado al país de El Salvador por el prolífico botánico estadounidense Paul C. Standley (1884–1963), maestro e investigador, quién visitó y recorrió gran parte del país por un período de 6 meses entre diciembre de 1921 y mayo de 1922, colectando y describiendo especies nuevas para la ciencia.

Comentarios.—Muchas de las especies de esta familia se han adaptado a vivir en hábitats extremadamente secos, por lo cual han desarrollado estructuras que permiten evitar la deshidratación, como pruína, pelos, espinas; hojas y tallos carnosos para acumular agua. Para sobrevivir bajo esas condiciones, se han espe-

cializado en métodos de reproducción vegetativa, como gémulas, renuevos estériles, hojas enraizantes y tallos cundidores entre otros. *S. salvadorense* tiene un potencial ornamental por sus bellas flores blancas-amarillentas y por sus características de sobrevivencia en condiciones adversas.

Durante mucho tiempo no se supo nada de esta especie considerándola extinta. Fue hasta 1997 que E. Sandoval s.n. (LAGU) y E. Sandoval 1884 (LAGU, MO, B, BM, EAP) la colectó, es decir 75 años después de la primera colecta de Paul C. Standley. Sin embargo, es hasta 2009 y 2012 que pudo ser colectada y documentada fotográficamente por los autores, detallando de forma precisa la georeferenciación de las localidades, pues las coordenadas de las otras colectas no fueron asignadas en el campo sino en el herbario, tomando como punto de referencia la entrada principal del Parque Nacional "El Imposible" y no el hábitat donde naturalmente crece.

CONCLUSIONES

En referencia al Estado de Conservación de esta especie; creemos que las plantas dentro del área del Parque Nacional El Imposible son poco frecuentes considerándose extintas en otras zonas debido al alto grado de deterioro y fragmentación de su hábitat. De acuerdo con los criterios de la Lista Roja de Especies Amenazadas (UICN 2012) y según las observaciones de los autores, estas plantas son las únicas poblaciones conocidas dentro del Parque Nacional El Imposible, por lo tanto la categoría para esta especie sería Vulnerable, VU A1(d).

AGRADECIMIENTOS

Nuestra gratitud a los dos revisores uno anónimo y para Tiana Rehman de BRIT por sus valiosos comentarios y observaciones. También a Barney Lipscomb por su valiosa revisión, acotaciones, paciencia y apoyo en esta publicación que contribuirá al conocimiento de la flora salvadoreña.

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REDISCOVERY OF *CALLIRHOE PAPAVER* (MALVACEAE) IN ALABAMA (U.S.A.)

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ABSTRACT

Recent collections document the presence of *Callirhoe papaver* (Malvaceae) in the Jackson Prairie region of southwestern Alabama. This species was last collected in the state during the 1870s and was designated as "historic" in the recent *Annotated Checklist of the Vascular Plants of Alabama* because the last known collection was from 1873. Here we describe the history of its collection in Alabama and its rediscovery in 2012.

RESUMEN

Colecciones recientes documentan la presencia de *Callirhoe papaver* (Malvaceae) en la región de Jackson Prairie del sudoeste de Alabama. Esta especie se colectó en el estado por última vez en los 1870s y fue designada como "histórica" en la reciente *Annotated Checklist of the Vascular Plants of Alabama* poque la última colección conocida era de 1873. Describimos aquí la historia de su colección en Alabama y su redescubrimiento en 2012.

The woodland poppy-mallow, *Callirhoe papaver* (Cav.) A. Gray, occurs in calcareous habitats along the southeastern Coastal Plain from Georgia and Florida, west to eastern Texas. It is considered uncommon and local in southwestern Georgia, northern Florida, Alabama, and Mississippi, while considerably more widespread west of the Mississippi River (Dorr 1990). In Mississippi and Alabama, it has been specifically attributed to the Pine Hills or Lower Pine Region in the southern portions of both states (Mohr 1901; Dorr 1990).

In a recent treatment of the Alabama vascular flora (Kral et al. 2011), *Callirhoe papaver* was treated as "historic" or not collected in over 100 years and was mistakenly omitted from the latest inventory of rare, threatened, and endangered species (ALNHP 2012). The 2012 rediscovery of *C. papaver* in Washington County, Alabama, reported here, is thus significant.

HISTORICAL SPECIMENS

Charles Mohr (1824–1901), in his monumental *Plant Life of Alabama* (Mohr 1901), listed *Callirhoe papaver* only from Healing Springs in northern Washington County. His citation "Herb. Geol. Surv. Herb. Mohr" was based on a single collection (UNA 10851; Fig. 1) that he made in July, 1873. "Herb. Geol. Surv." refers to the collection that Mohr made for the Geological Survey of Alabama upon which his book was based (Davenport 1978, 1979a, 1979b). That collection of over 4000 specimens, long maintained separately as the herbarium of the Alabama Museum of Natural History (ALU), is now incorporated into the University of Alabama Herbarium (UNA).

The ALU collection was started in late 1878, when Eugene Allen Smith (1841–1927), long-time Alabama State Geologist (see Henderson 2011), asked Mohr for help with his plant identifications. (Mohr's polite acceptance [Mohr 1878] of Smith's request is housed in the University of Alabama Special Collections.) Their collaboration soon led to the privately published *Preliminary List of the Plants Growing Without Cultivation in Alabama* (Mohr 1880). In that list, *Callirhoe papaver* was noted as occurring only in Washington County, with Mohr ("M") as its collector.

In contrast, "Herb. Mohr" refers to Mohr's much larger personal herbarium, which he bequeathed to the Smithsonian Institution (US) (Anonymous 1901). Two Alabama *Callirhoe papaver* specimens are currently found at US. The first (US 774668; Fig. 2) has two labels. The first, original label is affixed to the lower-left

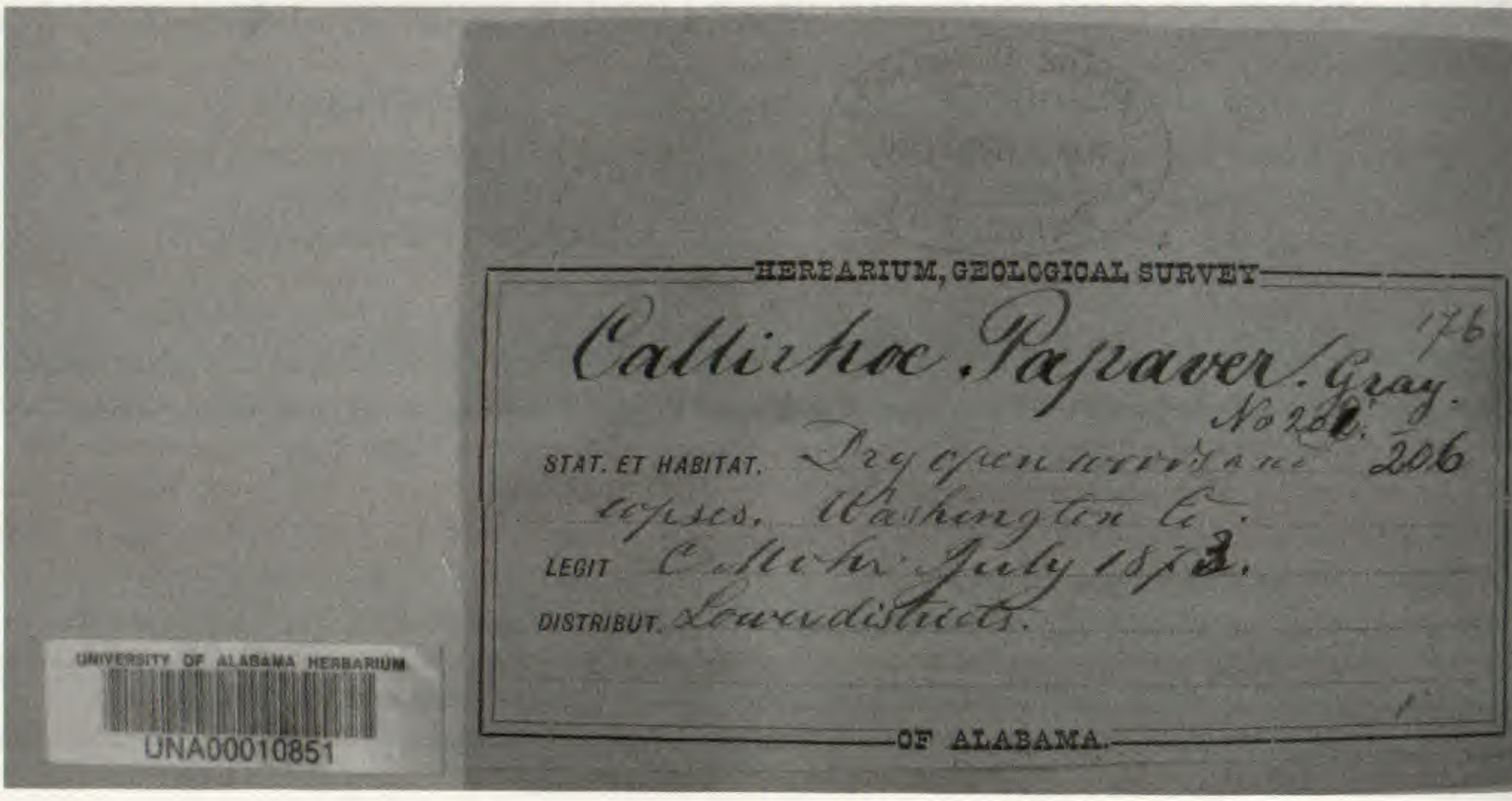

Fig. 1. Specimen label of *Callirhoe papaver* collected by Charles Mohr (UNA 10851): "Dry open woods and copses. Washington Co., C. Mohr, July 1873."

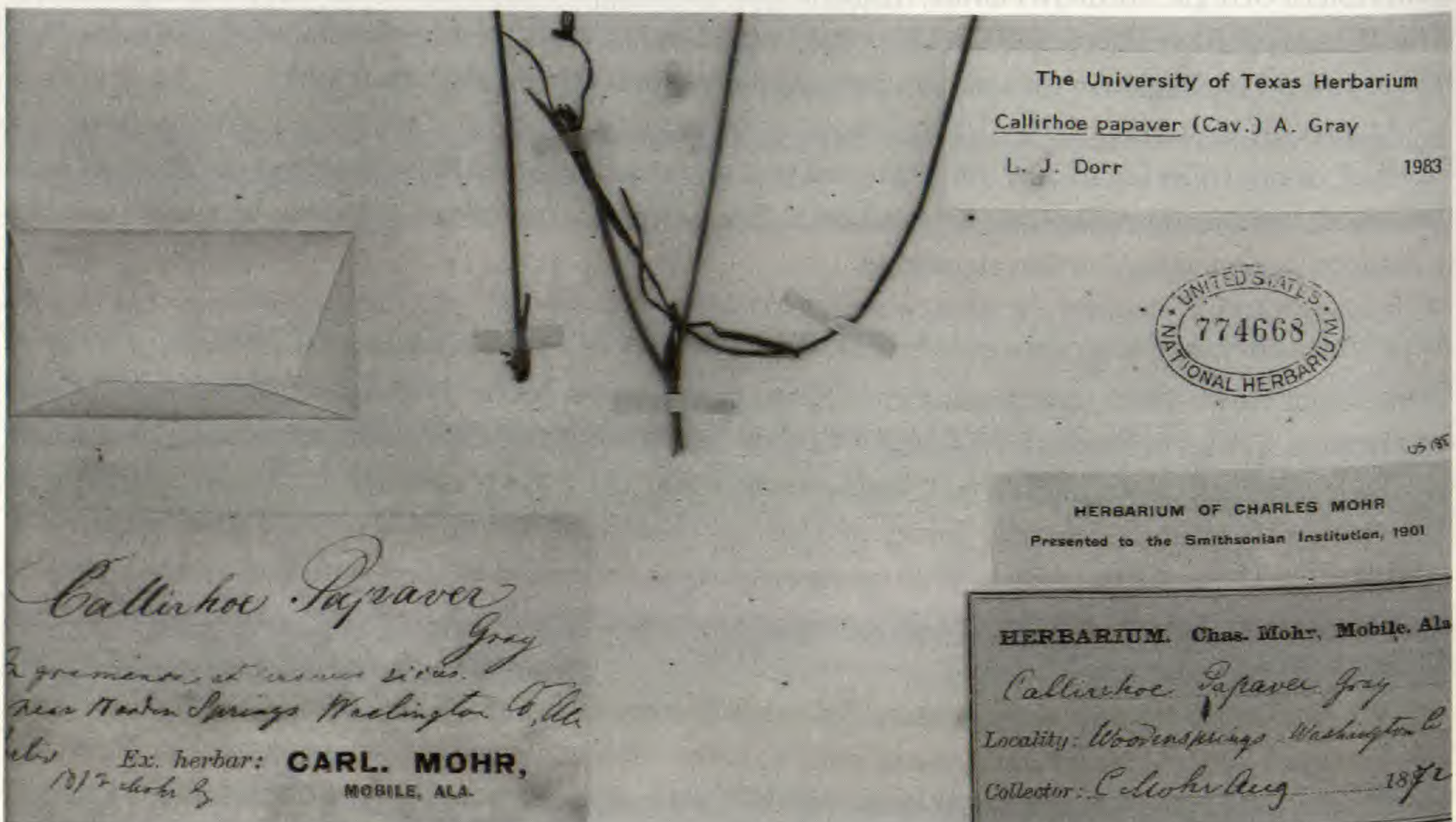

Fig. 2. Specimen labels of *Callirhoe papaver* collected by Charles Mohr (US 774668): "Woodensprings, Washington Co, C. Mohr, Aug 1872."

corner; it has a printed "Carl. Mohr" with the locality data and several sets of notes by Mohr, made at different times. The second label, placed in the traditional lower-right corner, is a newer one, copied by Mohr, with "Woodensprings, Washington Co" and "Aug 1872."

The above locality, subsequently recorded by Dorr (1990) as "Wooden Springs," is misspelled. Mohr, who sought the healing powers of mineral baths and more healthful climates throughout his adult life (Davenport 1978, 1979a), was most likely one of the first customers at a resort founded by William Wooten in 1872 (Sulzby

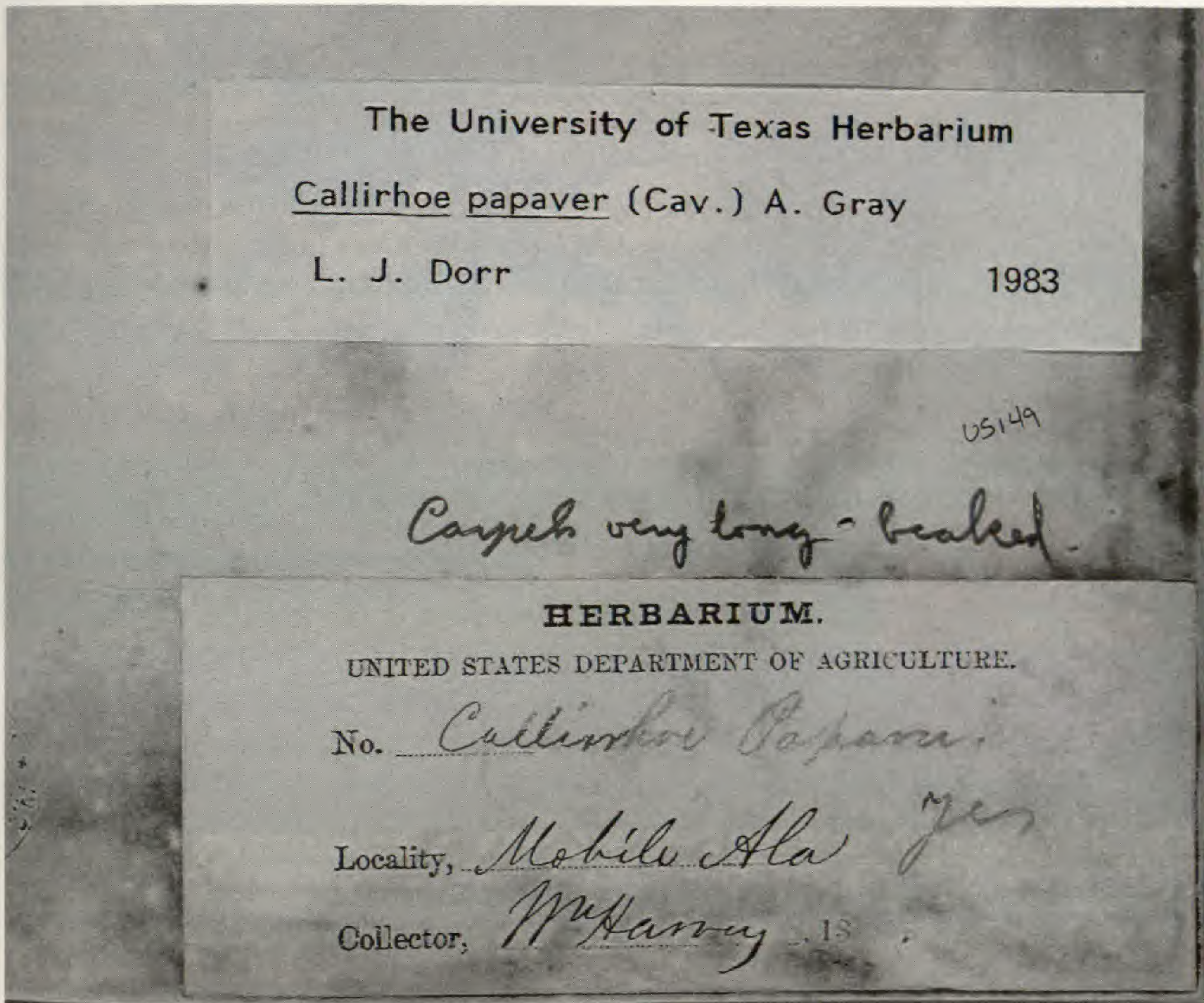

Fig. 3. William Harvey specimen (US 11818) of *Callirhoe papaver* with generic label in Charles Mohr's handwriting: "Mobile Ala, Wm Harvey [s.d.]."

1960; Foscue 1989). That resort, built around 17 small springs along a branch of Santa Bogue Creek in northern Washington County, Alabama, was perhaps initially known as "Wooten Springs" after the name of its developer, then changed to "Healing Springs" in order to attract more customers.

The second US specimen (US 11818; Fig. 3) lacks important details. The label is a generic one used at US during the late 1800s and was probably placed *ex post facto*. Thus, the species' identification, locality, and collector's name ("Mobile Ala; Wm Harvey") are clearly in Mohr's handwriting and not original notes by the collector. A significant omission is that no collection date is recorded on the label.

Who was "Wm Harvey"? An 1871 Mobile city directory lists a William Harvey as a route agent for the Mobile & Ohio Railroad (Ancestry.com 2011). Because no such person is listed in either the 1870 or 1880 United States Censuses, Harvey must have only lived briefly in Mobile. According to a U.S. Commissioner of Agriculture Affairs report (Watts 1875), that department received a "package of plants collected near Mobile, Alabama, by Mr. William Harvey" during 1874. Most likely, that package contained Harvey's *Callirhoe papaver* specimen—perhaps collected at a stop along the Mobile & Ohio Railroad line, which ran within 13 miles of Healing Springs.

Mohr probably didn't know about Harvey's collection at US until the 1890s. It was during that decade that he worked diligently on his flora of Alabama, and he visited US on several occasions (Davenport 1978, 1979a). During one of those visits, he must have been given Harvey's specimen to identify. On the label, Mohr wrote "Mobile" to indicate the collector's location and not the actual location of the specimen. Most importantly, he

Fig. 4. Jackson Prairie habitat of *Callirhoe papaver* (inset) in Washington County, Alabama; 20 Jun 2013.

did not include Mobile County—which lacks suitable calcareous habitat—as a *Callirhoe papaver* locality in *Plant Life of Alabama* (Mohr 1901). In his later monograph of the genus, Dorr (1990) attributed *C. papaver* to Mobile County by citing the Harvey specimen without knowledge of the specimen's history outlined above.

REDISCOVERY IN ALABAMA

During a 2012 botanical survey of the "Limestone" or "Jackson Prairie" region of southwestern Alabama, a collection of *Callirhoe papaver* was made by the first author in Washington County. The locality is ca. 4.2 miles NNE of Healing/Wooden/Wooten Springs, the only "original" Alabama locality. This population contained approximately 40 individuals.

In 2013, the above locality was revisited one year later. *Callirhoe papaver* and associated species seemed to be slightly delayed in flowering time from the previous year. Further exploration in 2013 (*Keener et al. 7955*) resulted in the discovery of an additional population of 10 individuals 3.4 miles ENE of the 2012 locality (*Keener et al. 7344*).

Voucher specimens: **ALABAMA. Washington Co.:** 3.8 air mi N of Millry, prairie W of Brier Creek, 31.69025°N, 88.31505°W, 24 Jun 2012, *B.R. Keener 7344 with W.K. Webb* (UWAL, SAMF, TROY, VDB); 4.3 air mi NE of Millry, along primitive private road ca. 1.6 mi E of jct. with Co. Rd. 45 (Mt. Carmel Rd.), 31.67720°N, 88.26003°W, 21 Jun 2013, *Brian R. Keener 7955 with A.R. Diamond, L.J. Davenport & W.K. Webb* (UWAL).

The soils of both sites are clay with occasional thin areas of exposed limestone. The *Callirhoe* plants grow in full sun or along the margin of prairie woods dominated by eastern red-cedar (*Juniperus virginiana* L.) (Fig. 4). Associated herbaceous species are *Asclepias viridis* Walter, *Echinacea purpurea* (L.) Moench, *Polygala boykinii* Nutt., *P. violacea* Aubl., *Silphium laevigatum* Pursh, and *Tripsacum dactyloides* (L.) L. Unfortunately, the sites are dominated by the invasive cogon grass, *Imperata cylindrica* (L.) P. Beauv.

In light of *Callirhoe papaver* being treated as "historic" and its "disappearance" from the Alabama flora since the early 1870s, the above collections are deemed noteworthy. While *C. papaver* is seemingly a globally secure taxon, it remains as one of Alabama's rarest vascular plant species.

ACKNOWLEDGMENTS

We thank Deborah Bell (US) and Steve Ginzbarg (UNA) for providing images of herbarium specimens. We greatly acknowledge the field assistance of Wayne Webb and Alvin Diamond. We thank John Hall for image editing assistance. We also thank John Clark (UNA) and Larry Dorr (US) for insightful comments that improved the manuscript.

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BOOK NOTICE

KENNETH D. HEIL, STEVE L. O'KANE, JR., LINDA MARY REEVES, AND ARNOLD CLIFFORD. 2013. **Flora of the Four Corners Region: Vascular Plants of the San Juan River Drainage. Arizona, Colorado, New Mexico, and Utah.** (ISBN-13: 978-1-930723-84-9, hbk). Missouri Botanical Garden Press, P.O. Box 299, Saint Louis, Missouri 63166-0299, U.S.A. (**Orders:** www.mbgpress.info, orders@mbgpress.org, 1-877-271-1930). $72.00, 1098 pp., 8 ½" × 11 ¼".

From the Foreword by Peter Raven, President of the Missouri Botanical Garden:

"Certainly, readers of Tony Hillerman's well-appreciated detective stories will appreciate the natural magnificence and geological diversity of the Four Corners region even if they have not had the pleasure of visiting the area personally. The botanical diversity of this region, so well described in this attractive and useful flora, is no less impressive. Clearly, the use of this book will inspire further studies and thus make possible an ever greater depth of knowledge about these plants and their position in the habitats where they occur."

From the publisher:

"The *Flora of the Four Corners* describes all of those species, subspecies, and varieties of vascular plants that grow spontaneously in the drainage basin of the San Juan River, a major tributary of the Colorado River. This region takes in major portions of Arizona, Colorado, New Mexico and Utah, and is centered on the Four Corners, the only spot in the United States where four states meet at a common point. The entire area encompasses 65,382 square kilometers (25,244 square miles), an area the size of West Virginia or Connecticut and about half the size of Alabama, Arkansas, New York, or North Carolina. The highest point is 4292 m (14,083 feet) at Mt. Eolus in the San Juan Mountains and the lowest point is 1130 m (3708 feet) where the San Juan River flows into Lake Powell (the Colorado River). Because of this elevation gradient, and the varying climates produced by local topography, vegetation in the study area varies from alpine tundra to coniferous forests, mountain shrublands, lowland sagebrush, blackbrush, and to the sparse communities seen on bare rocks and the scorching sides of low-elevation canyons."

REDISCOVERY OF *PERSEA BORBONIA* VAR. *BORBONIA* (LAURACEAE), *PROSOPIS GLANDULOSA* VAR. *GLANDULOSA* (FABACEAE), AND *PINUS PALUSTRIS* (PINACEAE) IN ARKANSAS, WITH THREE NEW ANGIOSPERM SPECIES FOR ARKANSAS (U.S.A.)

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ABSTRACT

Persea borbonia (L.) Spreng. var. *borbonia*, *Prosopis glandulosa* Torr. var. *glandulosa*, and *Pinus palustris* Mill. have been rediscovered as components of the Arkansas flora. *Persea borbonia* var. *borbonia* has not been documented in Arkansas since 1881, *Prosopis glandulosa* var. *glandulosa* not since 1955, and *Pinus palustris* not since 1983. Additionally, three species of angiosperms, *Gomphrena globosa* L., *Oxalis debilis* Kunth, and *Ruellia nudiflora* (Engelm. and A. Gray) Urb., are reported as new for Arkansas. *Oxalis debilis* is morphologically similar to, and easily confused with, *Oxalis articulata* Savigny, another non-native species of *Oxalis* that has been introduced and has become well established in Arkansas. A key to identification and photographs are included for the three *Oxalis* species with pink to lavender-colored flowers that occur in the Arkansas flora.

RESUMEN

Persea borbonia (L.) Spreng. var. *borbonia*, *Prosopis glandulosa* Torr. var. *glandulosa*, y *Pinus palustris* Mill. han sido redescubiertas como componentes a la flora de Arkansas. *Persea borbonia* var. *borbonia* no ha sido documentada en Arkansas desde 1881, *Prosopis glandulosa* var. *glandulosa* desde 1955, y *Pinus palustris* desde 1983. Adicionalmente, tres especies de angiospermas, *Gomphrena globosa* L., *Oxalis debilis* Kunth, y *Ruellia nudiflora* (Engelm. and A. Gray) Urb., se citan como nuevas para Arkansas. *Oxalis debilis* es similar morfológicamente y, fácilmente confundida con, *Oxalis articulata* Savigny, otra especie alóctona de *Oxalis* que ha sido introducida y se ha establecido bien en Arkansas. Se incluyen una clave de identificación y fotografías de las tres especies de *Oxalis* con flores coloreadas de rosa a lavanda que se dan el la flora de Arkansas.

INTRODUCTION

Though vascular plant floristics in Arkansas is widely considered to have commenced with the 1819 exploratory travels of Thomas Nuttall, one of the first trained botanists to visit the area as documented by his 1835 collections publication, much additional floristic investigation has been conducted on the Arkansas flora over the past century, including the publication of over 1,200 articles by nearly 100 botanists documenting and explaining the diversity, abundance, and distribution of the state's flora and vegetation (Peck & Peck 1988; Peck et al. 2001; Peck 2003). Continued floristic work in Arkansas led to the establishment of the Arkansas Vascular Flora Committee (AVFC) in 1998, tasked with the creation of a checklist, atlas, and identification manual for the nearly 3,000 species of native and naturalized vascular plants present in the flora. The AVFC published the *Checklist of the Vascular Plants of Arkansas* in 2006, with the *Atlas of the Vascular Plants of Arkansas* set for publication in late 2013. Over the past decade, numerous species have been added to the state's flora, a number of which were non-native to the U.S. (Peck & Serviss 2006; Serviss & Peck 2008; Serviss 2009; Peck 2011a, 2011b; Peck & Serviss 2011; Serviss et al. 2012), and although recent work by the authors has focused on exotic species in urban and semi-urban environments, field work in 2012 and 2013 led to the rediscovery of two rare (in Arkansas), native, woody species of angiosperms, *Persea borbonia* var. *borbonia* and *Prosopis glandulosa* var. *glandulosa*, that have not been encountered in the Arkansas flora for well over 50 years, and one gymnosperm species, *Pinus palustris*, which has not been documented in the state for 30 years. These rediscov-

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Fig. 1. Photographs of *Oxalis debilis*, *Oxalis articulata*, and *Oxalis violacea* for comparison. **A.** *Oxalis debilis*, plant and flowers. **B.** *Oxalis articulata*, plant and flowers. **C.** *Oxalis violacea*, plant and flowers (photograph of *O. violacea* by Renn Tumlison, Henderson State University).

Fig. 2. Herbarium specimens of *Oxalis debilis*, *Oxalis articulata*, and *Oxalis violacea* for comparison. **A.** *Oxalis debilis*. **B.** *Oxalis articulata*. **C.** *Oxalis violacea*.

eries vibrantly illustrate the fact that in-depth and comprehensive floristic investigation must continue to occur in Arkansas.

REDISCOVERIES IN THE ARKANSAS FLORA

Persea borbonia (L.) Spreng. var. **borbonia** (Lauraceae), Red Bay. *Persea borbonia* var. *borbonia* is a shrub or small to medium-sized tree that is native to the southeastern U.S. from eastern Texas and Louisiana to Florida, Georgia, and North Carolina (Wofford 1997). The only previous record of *P. borbonia* var. *borbonia* in Arkansas is from Miller County (*F.L. Harvey s.n.*, 18 Aug, no year present on voucher, UARK). The specific location data of the Harvey *P. borbonia* var. *borbonia* specimen is ambiguous; however, Tucker (1974) elaborated somewhat on the location, indicating that it was collected "in the vicinity of Texarkana in swampy habitat." *Persea borbonia* var. *borbonia* has not been collected in Arkansas since 1881 (Harvey 1883; Tucker 1974; Smith 1988).

Voucher specimen: **ARKANSAS. Union Co.:** a few trees and many additional shrubs growing in thicket along shore of backwater area in mucky, sandy soil, Beryl Anthony Lower Ouachita WMA, 26 Sep 2012, *Peck 2012189* (HEND).

Prosopis glandulosa Torr. var. **glandulosa** (Fabaceae), Mesquite. *Prosopis glandulosa* var. *glandulosa* is a shrub

or small tree that is native and widespread throughout much of the southwestern U.S., southern and central Great Plains, and Mexico (McGregor 1986; Isely 1998). Tucker (1976) reported this species from Pulaski County in Arkansas based on collections by D.M. Moore in 1954 and 1955, noting that it was a "true inventive" of potentially long duration that was collected along the railroad tracks on the southern edge of Little Rock, apparently brought in with livestock. Smith (1978, 1988, 1994) excluded this species from the Arkansas flora, considering it to be only a waif, and not "part of the normal flora", but Peck (2003) reinstated *P. glandulosa* var. *glandulosa* as a component of the Arkansas flora based on the Moore vouchers (*Moore 54343, 55517*, UARK); however, *P. glandulosa* var. *glandulosa* has not been collected in Arkansas since 1955 (Peck 2003).

Voucher specimen: **ARKANSAS. Little River Co.:** one tree with flowers and six nonflowering shrubs growing in riverine lowland woods along the Red River, next to oxbow lake with sandy soil, off of state hwy. 41, Hudson Lake area, 6 Apr 2013, *Peck 2013001* (HEND).

Pinus palustris Mill. (Pinaceae), Longleaf Pine. *Pinus palustris* is a large tree that is native to the southeastern U.S. from eastern Texas and Louisiana to Florida, the Carolinas, and Virginia (Kral 1993). Shepherd and Amason documented this species from Arkansas in Union County in 1983 (*Shepherd and Amason 187*, UARK). This specimen was cited by Smith (1988), but he considered it as a possible "long-lived waif" and not truly a component of the state's flora. The 1983 Union County specimen of *P. palustris* is the only previous record of this species from Arkansas (our record is a distinct plant from that of the Shepherd and Amason record).

Voucher specimen: **ARKANSAS. Union Co.:** single tree, possibly adventive or persisting from arboricultural practices, growing at edge of regrowth pine tree farm from former hardwoods, but now mixed loblolly pine stand, mucky, sandy soil, along timber access road, 3 mi E of Junction City, 26 Jun 2013, *Peck 2013011* (HEND).

ADDITIONS TO THE ARKANSAS FLORA

Gomphrena globosa L. (Amaranthaceae), Globe Amaranth. *Gomphrena globosa* is an annual species native to tropical Asia and is commonly cultivated for its colorful, long-lasting flowers. *Gomphrena globosa* is sporadically naturalized in several southeastern states, including Louisiana and Texas, along with several states in the northeastern U.S. from Ohio and Virginia eastward to Massachusetts and New York (USDA, NRCS 2013). *Gomphrena globosa* is a prolific, self-seeding species and should be expected in other locations in Arkansas, especially in the vicinity of areas where plants of *G. globosa* are cultivated.

Voucher specimen: **ARKANSAS. Pulaski Co.:** several clusters or colonies of plants growing in sandy soil of the Arkansas River flood plain, Little Rock, Twin Rivers County Park, 28 Jul 2007, *Peck 07–1673* (HEND).

Oxalis debilis Kunth (Oxalidaceae), Pink Woodsorrel. *Oxalis debilis* is native to tropical America, but is naturalized in several southeastern states from Texas eastward to Florida and South Carolina (Nesom 2009; USDA, NRCS 2013; Figs. 1, 2). In Arkansas, *O. debilis* is weedy, occurring and spreading rapidly in areas with high disturbance, including flower beds, shrub plantings, lawns, and roadsides. *Oxalis debilis* is easily confused with another introduced species of *Oxalis*, *O. articulata* Savigny (Windowbox Woodsorrel; Figs. 1, 2). *Oxalis articulata* is native to Brazil and Argentina, and is naturalized in Arkansas and other areas in the southern U.S. *Oxalis articulata* is documented in Arkansas from several counties, but based on its overall morphological resemblance and similarity to *O. debilis*, some specimens of *O. articulata* could be misidentified and may be, in fact, *O. debilis*. *Oxalis debilis* can readily be distinguished from both *O. articulata* and the native *O. violacea* L. (Violet Woodsorrel; Figs. 1, 2) by the following key (modified from Wunderlin 1998; Horne et al. 2013).

KEY TO *OXALIS* SPECIES IN ARKANSAS WITH PINK, LAVENDER, OR PURPLE FLOWERS

1. Sepals pubescent with appressed, short-pilose trichomes; callosities present mostly along margins of leaflets; plants arising from a thick, often elongate, irregularly nodulate-segmented rhizome ____ **O. articulata**
1. Sepals glabrous or at most sparsely pubescent; callosities usually distributed over most or the entire surface of leaflets (or only at the apical notch in *O. violacea*); plants arising from a dense cluster of bulblets or a single bulb.
   2. Leaflets 2.5–4.5 cm long ____ **O. debilis**
   2. Leaflets 0.8–1.5 cm long ____ **O. violacea**

Voucher specimens: **ARKANSAS. Clark Co.:** hundreds of plants in lawn and shrub plantings, spreading via bulblets and possibly also seed,

Arkadelphia, Henderson State University campus, 2 May 2005, *Serviss 6958* (HEND); several plants in highly disturbed area along north side of building, Arkadelphia, Clark County Library, 700 block off of Caddo Street, 18 Jun 2013, *Serviss 8016* (HEND).

Ruellia nudiflora (Engelm. and A. Gray) Urb. (Acanthaceae), Violet Wild Petunia. *Ruellia nudiflora* is native to the southwestern U.S. (Arizona and Texas) and Mexico (Bailey & Bailey 1976). It has also been documented from Louisiana and Mississippi, but it is unclear whether or not it is native or introduced in those states (USDA, NRCS 2013). *Ruellia nudiflora* is probably not native in Arkansas, but rather an introduction via seed or plant contaminants in horticultural materials (soil, mulch, or potted ornamentals). *Ruellia nudiflora* is a robust perennial that prolifically self-seeds; thus, accidental introduction via horticultural endeavors seems plausible.

Voucher specimen: **ARKANSAS. Clark Co.:** several reproductive and smaller, sterile plants growing in lawn and cracks of adjacent walkway, Arkadelphia, Henderson State University campus, 2 Jul 2012, *Serviss 7488* (HEND).

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BOOK REVIEWS

JON FARRAR. 2011. **Field Guide to Wildflowers of Nebraska and the Great Plains.** (ISBN-13: 978-1-60938-071-7, pbk). University of Iowa Press, 119 W. Park Road, 100 Kuhl House, Iowa City, Iowa 52242-1000, U.S.A. (**Orders:** uiowapress.org, 1-800-621-2736). $39.95, 384 pp., 279 color photos, 2 color maps, 83 drawings, 6" × 9 1/8".

"After being out-of-print for nearly 20 years, and outrageously high prices being paid for dog-eared, first-edition copies, it is a joy to again have *Field Guide to Wildflowers of Nebraska and the Great Plains* riding along on car seats or in backpacks as wild-flower enthusiasts explore prairies, wildlands, and wetlands in search of those ever-changing splashes of color we call wildflowers. This second edition is much like the beloved first edition, but better."—*Jon Farrar*

Flower lovers are not all professionally trained botanists. Therefore, identification by color has become the more common practice if the pictures are included in various publications. This book has sections for Green Flowers; White Flowers; Yellow Flowers; Orange to Red Flowers; Pink to Red-Violet Flowers; and Blue-Violet to Blue Flowers. And, of course, it includes an illustrated glossary, references, and also additional reading selections.

The photography in this volume is outstanding. Colors ring true, and the pictures are large enough to be able to see easily and enjoy immensely. Additional line drawings of various plants and/or plant parts also show up occasionally, carefully identified or explained.—*Helen Jeude, Volunteer, Botanical Research Institute of Texas, Fort Worth, Texas, U.S.A.*

TIMOTHY P. SPIRA. 2011. **Wildflowers & Plant Communities of the Southern Appalachian Mountains & Piedmont: A Naturalist's Guide to the Carolinas, Virginia, Tennessee, & Georgia.** (Southern Gateway Guides). (ISBN-13: 978-0-8078-7172-0, pbk). University of North Carolina Press, 116 South Boundary Street, Chapel Hill, North Carolina 27514-3808, U.S.A. (**Orders:** uncpress.unc.edu, 1-800-848-6224). $26.00, 540 pp., 361 color photos, 760 color thumbnails, 22 line drawings, 2 maps, bibl., index, 6" × 9".

Not only is Tim Spira an excellent botanist, author, and presenter, he has an amazing ability to bring the flora alive and keep the reader totally engrossed for all 500+ pages. The illustrations are absolutely beautiful; the descriptions are precise; and the information keeps the reader happily reading and anxious to get on the road and go visit the Southern Appalachian Mountains and Piedmont.

This hefty volume is also easy to use. The author thoughtfully designed the volume to indicate the specific pages for each part by identifying it with a specific color along the edge of the page. (The closed book will show a specific color for each section.) In addition, instead of lumping descriptions of plants by color, a system frequently used, Spira explains: "The key idea at the center of the book is the organization of plants into 21 major communities. Often, you'll see wildflower books organized by flower color or family affinity, but the natural community emphasis used here is an exciting, fresh approach that is connected to our growing understanding of the environment and how all parts of the natural world are mutually dependent."

This is an incredibly beautiful and fascinating book, and the reader will find him- or herself going back to it repeatedly. Moreover, the book is of a quality that it should not be easily damaged if you have taken it into the field and are using it carefully. The author has presented us with an exceptionally beautiful and helpful volume.—*Helen Jeude, Volunteer, Botanical Research Institute of Texas, Fort Worth, Texas, U.S.A.*

A FLORISTIC INVENTORY OF PHILLIPS AND VALLEY COUNTIES, MONTANA (U.S.A.)

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ABSTRACT

This study marks the first floristic inventory of Phillips and Valley counties on the glaciated plains of northeastern Montana. The 23,191 sq km (8,954 sq mi) area was surveyed for all vascular plant taxa on lands managed by the Bureau of Land Management, U.S. Fish and Wildlife Service, State of Montana, American Prairie Reserve, and The Nature Conservancy. In the summers of 2010 and 2011, 12,768 voucher specimens were collected from 308 sites documenting 762 unique taxa, 718 species, and 358 genera from 86 families. Among these are 108 taxa exotic to Montana, nine noxious weed species, and 15 taxa of conservation concern. Approximately 30 percent of the taxa collected are newly documented within the area. An additional 70 taxa previously collected by other workers and housed at MONT, MONTU, or RM/USFS raised the total number of unique taxa to 832. Results are enumerated in an annotated checklist and vegetation types are described. Analyses of the study's sampling adequacy are also discussed.

RESUMEN

Este estudio marca el primer inventario florístico de los condados de Phillips y Valley de las llanuras glaciadas del noreste de Montana. El área de 23.191 km2 (8.954 sq mi) fue estudiada en busca de todos los taxa de plantas vasculares en los espacios manejados por el Bureau of Land Management, U.S. Fish and Wildlife Service, Estado de Montana, American Prairie Reserve, y The Nature Conservancy. En los veranos de 2010 y 2011, se colectaron 12.768 especimenes testigo de 308 lugares que documentan 762 taxa únicos, 718 especies, y 358 géneros de 86 familias. Entre estos se encuentran 108 taxa exóticos en Montana, nueve malas hierbas nocivas, y 15 taxa de preocupación en su conservación. Aproximadamente el 30 por ciento de los taxa colectados se documentan como nuevos en el área. 70 taxa adicionales previamente colectados por otros Investigadores y conservados en MONT, MONTU, o RM/USFS elevan el número total de taxa únicos a 832. Los resultados se enumeran en un catálogo anotado y se describen los tipos de vegetación. También se discuten los análisis la adecuación del muestreo.

INTRODUCTION

We report on a vascular plant inventory of public and private lands in Phillips and Valley counties in northeastern Montana (Fig. 1). The area is bound by Canada to the north, the Missouri River to the south, Daniels County and Fort Peck Indian Reservation to the east, and Blaine County and Fort Belknap Indian Reservation to the west. Elevation ranges from 616 to 1,743 m (2,020 to 5,720 ft).

The area is located within the North American Prairies floristic province near the edge of the Rocky Mountain province (Takhtajan 1986), although Lavin and Seibert (2011) have suggested that the area has a greater floristic affinity to the Intermountain region than to the Great Plains. Botanical exploration of the area began in 1805 and 1806 when the Lewis and Clark Expedition traveled along the Missouri River (Phillips 2003). Past treatments that have covered the area include Rydberg (1932; peripherally), *Atlas of the Flora of the Great Plains* (GPFA 1977), and *Flora of the Great Plains* (GPFA 1986). State floras include *Vascular Plants of Montana* (Dorn 1984) and the recently published *Manual of Montana Vascular Plants* (Lesica 2012). The area is one of many on the western Great Plains for which basic floristic knowledge has been lacking (GPFA 1986). Indeed, the area was not previously well collected: fewer than 1,200 collections from this area larger than the State of New Jersey are vouchered at the Montana State University Herbarium (MONT; 2013) and the University of Montana Herbarium (MONTU; 2013).

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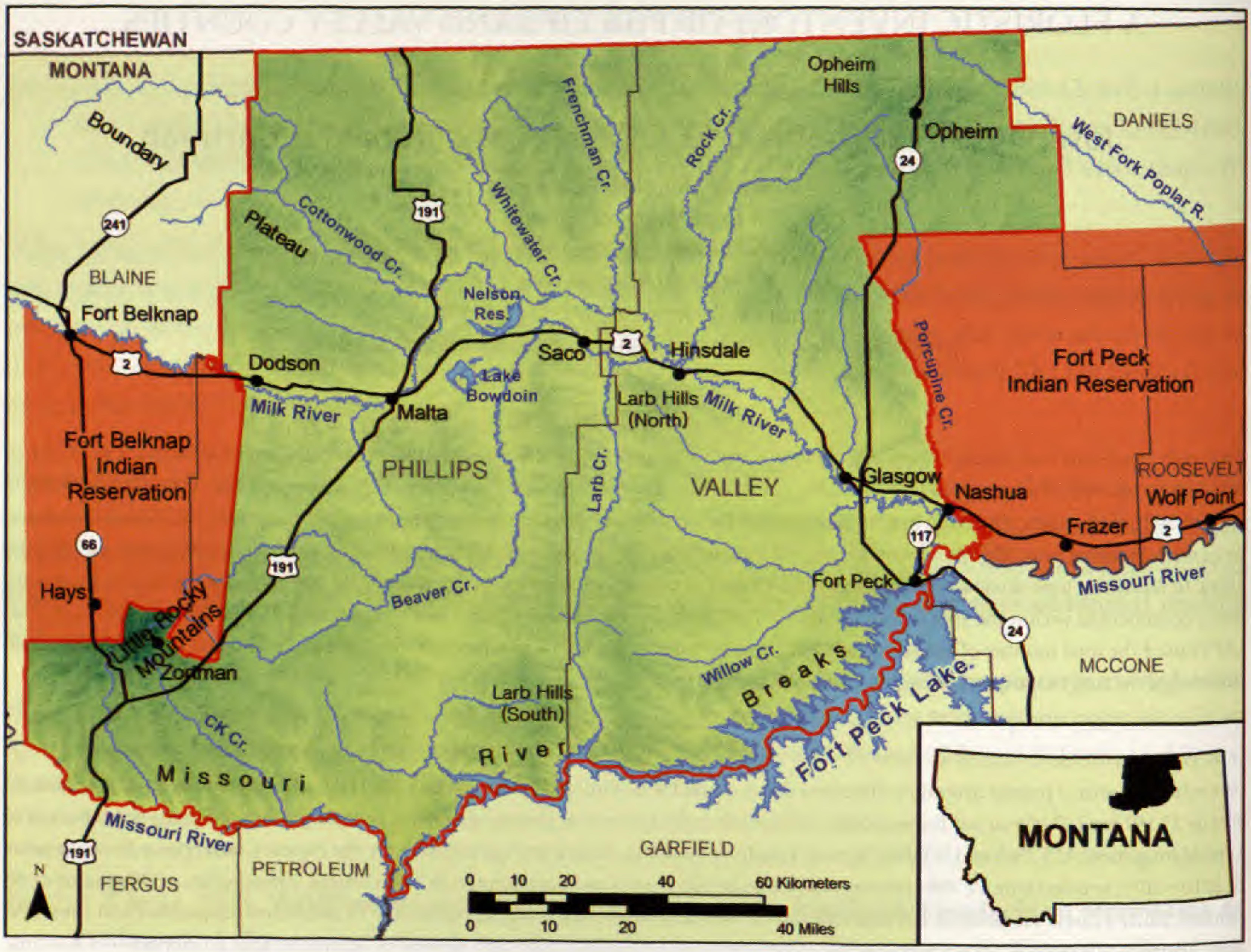

Fig. 1. General map of the study area (outlined in red), which comprises 23,191 sq km (8,954 sq mi) in northeastern Montana. Elevation ranges from 616–1,743 m (2,020–5,720 ft).

This botanical inventory is part of the larger effort by the Rocky Mountain Herbarium (RM) to map in relatively fine detail the geographic distributions of species based on vouchered specimens and to produce a flora of the greater Rocky Mountain region (Hartman 1992; Hartman & Nelson 2008; Hartman et al. 2009). Thus, floristic inventories (49 as master's degree projects) have been conducted during the past 34 years in Arizona, Colorado, Idaho, Kansas, Montana, Nebraska, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming (e.g. Reif et al. 2009; Kesonie & Hartman 2011; Kuhn et al. 2011; Lukas et al. 2012). Over 650,000 new collections have been obtained by graduate students, staff, and research associates of RM. These specimens form the core of the RM Plant Specimen Database (835,000 specimen records, 55,000 specimen images, and 4,000 field images; Hartman et al. 2009).

Study area.—Various federal and state agencies manage lands in the area. In Phillips County, 4,374 sq km (1,689 sq mi) of Bureau of Land Management (BLM) lands are managed by the Malta BLM Field Office or in the southwest corner of the county as part of the Upper Missouri River Breaks National Monument, which is administered directly by the Montana/Dakotas BLM. The Glasgow BLM Field Office manages 4,095 sq km (1,581 sq mi) in Valley County. Also covered were 1,563 sq km (603 sq mi) of U.S. Fish and Wildlife Service lands including Charles M. Russell National Wildlife Refuge north of the Missouri River as well as Bowdoin National Wildlife Refuge. The area also includes 1,635 sq km (631 sq mi) managed by the state, mostly as Montana State Trust Lands or by Montana Fish, Wildlife, and Parks. Private lands visited include the American Prairie Reserve (133 sq km/51 sq mi) in southern Phillips County and the Matador Ranch (123 sq km/49 sq mi), owned and operated by The Nature Conservancy in southwestern Phillips County. In total, 11,924 sq km (4,604 sq mi)

were accessible for collection within the 23,191 sq km (8,954 sq mi) area (the entirety of Phillips and Valley counties exclusive of lands on the Fort Peck and Fort Belknap Indian Reservations). There are four wilderness study areas (WSAs) managed by the BLM: Bitter Creek WSA (239 sq km/92 sq mi) in northern Valley County, Burnt Lodge WSA (56 sq km/21 sq mi) in the Larb Hills (South), and Antelope Creek WSA (50 sq km/19 sq mi) as well as part of Cow Creek WSA (138 sq km/53 sq mi in total) in the Upper Missouri River Breaks National Monument. Grasslands National Park of Canada is located just north of the area in Saskatchewan.

Physiography.—The area is located on the Glaciated Missouri Plateau subregion of the northwestern portion of the Great Plains physiographic region (Fenneman 1916). Figure 1 shows topographic features and bodies of water in the area. The vast majority of the area was glaciated during the Pleistocene (Colton et al. 1961; Fullerton & Colton 1986). Most of the area lies on broadly rolling hills with typically dry drainages, locally called coulees. Grasses dominate these rolling hills with sagebrush (*Artemisia* spp.) abundant in some areas as well. Topographic relief is greater in the south on the Missouri River Breaks, where steep slopes can be covered with ponderosa pine woodlands. The Little Rocky Mountains, one of several forested island mountain ranges in central Montana, rise about 610 m (2,000 ft) above the surrounding plains in southwestern Phillips County and southeastern Blaine County. The summit of Antoine Butte at 1,743 m (5,720 ft) is the highest point in the Little Rockies and the area.

The entire area is located within the Missouri River watershed. Most of the area drains into the Milk River except several drainages in the south that lead directly to the Missouri River and part of northeastern Valley County, which is in the Poplar River watershed. The Milk River nearly bisects the area, entering in the west near Dodson and reaching its confluence with the Missouri River in the east (Fig. 1). The Missouri River is dammed near the town of Fort Peck by Fort Peck Dam, which was constructed by the U.S. Army Corps of Engineers during the 1930s (Bandy et al. 2004). Fort Peck Lake forms the shoreline of the Missouri River for much of its length within the area.

Climate.—The region has a cold semi-arid climate (BSk in the Köppen-Geiger climate classification; Peel et al. 2007), characterized by warm to hot summers and long cold winters (Bingham et al. 1984; Bandy et al. 2004; NCDC 2012). Average daily maximum temperatures range from 9.8 to 15.7°C (49.7 to 60.2°F), with the north cooler than the south (PRISM 2004). Average daily minimum temperatures range from -3.3 to 2.3°C (26.1 to 36.1°F), again generally lower in the north than in the south (PRISM 2004). Average annual precipitation is relatively low, ranging from 26.7 to 55.1 cm (10.5 to 21.7 in) in the Little Rocky Mountains (PRISM 2004). Areas of locally high elevations tend to receive more precipitation, including the Little Rockies. About half of the annual precipitation falls in the months of May, June, and July (NCDC 2012; WRCC 2012). Severe thunderstorms throughout the summer can bring locally heavy precipitation as well as damaging winds and hail (Bingham et al. 1984).

Precipitation was well above normal throughout most of the area in both field seasons of this inventory (2010 and 2011). Annual precipitation in 2010 at Glasgow was 46.0 cm (18.1 in; 156 percent of average) and in 2011 was 58.4 cm (23.0 in; 198 percent of average), the highest ever recorded in Glasgow (NCDC 2012; NWS 2012). In addition, the 275.8 cm (108.6 in) of snow that fell in Glasgow during the winter of 2010 and 2011 were the most ever recorded, more than three times greater than the average of 91 cm (36 in; NWS 2012). This abnormally high level of precipitation created excellent conditions for conducting a floristic inventory but brought extensive flooding as well.

Geology.—Three main events define the surficial geology of the area: the deposition of sedimentary rocks in a shallow inland sea during the Late Cretaceous, the formation of the Little Rocky Mountains during the early Paleogene, and the glaciation of nearly the entire area during the Pleistocene.

Throughout most of the area, the geologic layers exposed at the surface were deposited during the Late Cretaceous when a large, shallow, inland sea known as the Western Interior Seaway covered the region (Marshak 2005). Formations exposed from this time period are, from oldest to youngest, the Claggett shale, the Judith River formation, the Bearpaw shale, the Fox Hills sandstone, and the Hell Creek formation (Collier 1918; Vuke et al. 2007). The most commonly exposed of these Cretaceous-age materials is the Bearpaw shale (Vuke

et al. 2007). It consists of mostly dark-gray shale of marine origin and in some areas forms badlands and sticky clay soils known locally as gumbo (Collier 1918; Jensen & Varnes 1964). Localized bentonite layers in the Bearpaw shale, derived from volcanic ash deposits, have been mined in the area (Jensen & Varnes 1964; Bandy et al. 2004).

A structure called the Bowdoin dome exists in the central and northern portion of the area, centered about Nelson Reservoir and Lake Bowdoin (Bandy et al. 2004). Strata dip very slightly away from the center of the dome in all directions, which has resulted in weathering of younger overlying material and surface exposures of two older formations, the Claggett shale and the Judith River formation (Collier 1918; Vuke et al. 2007). The older Claggett shale, which outcrops at the center of the dome, consists of a dark-gray marine shale similar to the Bearpaw shale. The Judith River formation, which outcrops on the periphery of the dome, consists of sandstones and shale of a freshwater depositional environment (Collier 1918; Jensen & Varnes 1964). The Bowdoin dome has trapped natural gas in underlying Colorado Group sandstones (Bandy et al. 2004). Natural gas production from this dome has occurred since the early part of the 20th century and continues today (Bandy et al. 2004).

The Fox Hills sandstone and Hell Creek formation (famous for its dinosaur fossils; Jensen & Varnes 1964) outcrop in the southern part of the area as well as parts of northeastern Valley County (Collier 1918; Vuke et al. 2007). These consist of mostly sandstones (Bandy et al. 2004). The sandstones of the Hell Creek formation are more erosion resistant than the surrounding Bearpaw shale and often cap hills, particularly in the southern part of the area (Jensen & Varnes 1964).

The Flaxville gravel, derived from alluvial terrace deposits from the late Neogene and early Quaternary, is exposed in small parts of the north (Bandy et al. 2004). Resistant to erosion, it caps uplands and benches where it is exposed (Collier 1918). Alluvium from the Quaternary is present in the Milk River Valley and lower parts of larger creeks as well as on the Missouri River upstream of Fort Peck Lake (Bandy et al. 2004; Vuke et al. 2007).

The Little Rocky Mountains were formed during an early Paleogene orogeny in which intrusive igneous rocks uplifted Precambrian basement rocks and overlying Paleozoic and Mesozoic sedimentary rocks around the periphery of the range (Knechtel 1959). Precambrian metasedimentary and metavolcanic rocks outcrop along with igneous rocks in the center of the Little Rockies (Knechtel 1959; Bandy et al. 2004; Vuke et al. 2007). These igneous rocks at the core were intruded about 60 million years ago from alkaic magma (Wilson & Kyser 1988; Bandy et al. 2004). Gold and silver have been mined in the Little Rockies since 1884 in a variety of operations (Wilson & Kyser 1988; Bandy et al. 2004).

The sedimentary rocks overlying the Little Rocky Mountains were uplifted during the orogeny and subsequently have been eroded away over the core of the range, while remaining at the periphery (Knechtel 1959; Vuke et al. 2007). The most prominent strata exposed at the surface are erosion-resistant calcareous rocks from the Paleozoic, including dolomites of the Bighorn formation from the Ordovician, the Jefferson limestone of the Devonian, and especially the Lodgepole and Mission Canyon limestones of the Mississippian (Knechtel 1959). Mesozoic rocks outcrop mostly in the foothills surrounding the Little Rockies and in small areas within the range. These are mostly shales but also include some sandstones, conglomerates, and limestones (Knechtel 1959). Rocks from the Jurassic and Early Cretaceous are exposed in small areas around the periphery of the range but once on the plains, strata from the Upper Cretaceous dominate at the surface (Knechtel 1959; Vuke et al. 2007).

The Laurentide Ice Sheet covered the entire region during the late Illinoian glacial period (between 195,000 and 128,000 years ago) with the exception of the Little Rocky Mountains and an area east of Opheim within the Poplar River drainage (Colton et al. 1961; Fullerton & Colton 1986). Following this glacial period, extensive badlands formed subsequent to glaciation in the Wisconsinan (Fullerton & Colton 1986). Glaciers returned between 21,000 to 16,000 years ago during the late Wisconsinan, although to a much smaller extent than during the Illinoian (Fullerton & Colton 1986). During this time large areas remained ice-free in southern Phillips County, on the Boundary Plateau in northern Phillips County, and in much of Valley County, ex-

cluding the central portion (Colton et al. 1961; Fullerton & Colton 1986). Prior to these glacial episodes, the Missouri River formed the broad valley that the Milk River now meanders through (Collier 1918; Bingham et al. 1984; Bandy et al. 2004). Blocked by glacial ice, the Missouri River became entrenched in its current channel during the Wisconsinan (Collier 1918; Alden 1932).

Paleovegetation.—Vegetational history following deglaciation is somewhat uncertain because of a paucity of fossil pollen data from northern Montana (Barnosky 1989; Strong & Hills 2005). However, it is likely that after 12,000 years ago extensive grasslands similar to the present vegetation were established in the region, unlike areas further east and north, which supported long-standing wide bands of boreal forest following deglaciation (Strong & Hills 2005). Fossil pollen data from Guardipee Lake, Montana indicates that by 12,200 years ago, temperate grasslands with shrubs in mesic habitats were present in northern Montana east of the Rocky Mountains (Barnosky 1989). After 9,300 years ago these grasslands started to become more xeric as they are today (Barnosky 1989).

Less clear is the nature of the vegetation following the maximum extent of the Laurentide Ice Sheet about 20,000 years ago (Fullerton & Colton 1986) but prior to 12,000 years ago. There is no direct evidence for forests during this time, although the area may have been near the edges of both cordilleran and boreal forest belts. A dry deciduous boreal forest or aspen parkland may have existed south of the boreal/cordilleran forest zone in southern Saskatchewan (Klassen 1994), perhaps approaching northern Montana. The existence of a belt of cordilleran forests during this time may explain the distribution of these tree species in the island mountain ranges of central Montana and the Cypress Hills in Canada (Thompson & Kuijt 1976; Strong & Hills 2005). Presumably such a cordilleran forest belt stretched across the lowlands but was isolated after 14,000 years ago onto the discontinuous highlands of the region (Strong & Hills 2005), including the Little Rocky Mountains. Thompson and Kuijt (1976) believed this a more plausible explanation for the distribution of cordilleran conifers in the Cypress and Sweetgrass hills than long distance dispersal of seeds by wind or birds.

Soils and Agriculture.—Substrates are important in determining the distribution of plant species (Kruckeberg 2002), and in most of the area, soils rather than unweathered rocks are present at the surface. Many soils have developed from tills left following Illinoian and Wisconsinan glaciations. However, this till material is typically not far removed from its original source as the area was at the southern limit of the continental ice sheet and scouring power was minimal (Bandy et al. 2004). Therefore, these tills are derived primarily from Cretaceous shales. Tills are thickest in the northern part of the area, thinning to the south, or have been removed completely by erosion in some places (Bingham et al. 1984; Bandy et al. 2004). A few large glacial erratics have been deposited from as far away as the Hudson Bay (Collier 1918; Bandy et al. 2004).

Through their influence on vegetation, soils have also affected human settlement and agriculture. Soils developed from marine shales or their tills can be highly alkaline. This alkalinity combined with relatively low precipitation in the region make much of the land unsuited for cultivation (Cooper et al. 2001). Many homesteaders, who started to arrive following the establishment of the Great Northern Railway in 1887 (Bandy et al. 2004; now operated by the BNSF Railway), saw their farms go bankrupt during the Great Depression (Bingham et al. 1984). The BLM now manages many of these lands that were repurchased by the federal government under the Bankhead-Jones Farm Tenant Act of 1937 (Mackie 1970; Cooper et al. 2001). Today, most of the area is utilized for cattle grazing, and to a lesser extent, sheep grazing (Bandy et al. 2004). Dryland farming of small grains, including spring wheat, barley, and oats, as well as irrigated farming along the Milk River are still important as well (Bingham et al. 1984; Bandy et al. 2004). Today about 17 percent of the area is under cultivation (MTNHP 2010). The unsuitability of most of the area for cultivated agriculture and its use primarily as rangeland have left many of the grasslands and shrublands relatively intact (Cooper et al. 2001).

METHODS

The methods used for this inventory largely follow those employed by other graduate students and staff at RM for other floristic inventories in the greater Rocky Mountain region (Hartman 1992; Hartman & Nelson 2008; Reif et al. 2009; Kesonie & Hartman 2011; Kuhn et al. 2011; Lukas et al. 2012). Our primary objective was to

document the diversity of vascular plants across the area throughout the growing season through the collection of voucher specimens. As such, we chose individual collecting sites in the field rather than visiting a set of randomly distributed points. Collecting sites were selected for greatest potential diversity, often at the intersection of different vegetation types or on unique substrates, while spacing sites over the region during different months of the field season. At each collection site, we used the "meander" search strategy (Goff et al. 1982; Hartman 1992; Hartman & Nelson 2008). All species in flower or fruit or otherwise readily identifiable through vegetative characters were vouchered at each site visited and relevant habitat and location data (including GPS coordinates) were recorded. Specimens were collected within about 0.8 km (0.5 mi) of each recorded GPS point. Voucher specimens were collected, pressed, and dried in accordance with standard collecting techniques described in Hartman (1992) and Hartman and Nelson (2008).

Joseph L.M. Charboneau and B.E. Nelson made collections in the field seasons of 2010 and 2011. In 2010, we spent 53 person-days collecting between 8 June and 25 August and between 10 September and 21 September, generally alternating days collecting with days spent pressing. In 2011, between 10 May and 15 August, we spent 49 person-days collecting. In total, we made 12,768 collections from 308 sites at a density of 0.55 collections per sq km (1.43 per sq mi). Figure 2 contains a map of collection sites.

Specimens were identified using a number of floras including Dorn's *Vascular Plants of Montana* (1984), *Flora of the Great Plains* (GPFA 1986), Dorn's *Vascular Plants of Wyoming* (2001), and *Flora of North America* (1993+). All identifications were checked against specimens in RM verified by specialists. Nomenclature follows that of the RM Plant Specimen Database (Hartman et al. 2009). Specimen data have been entered into this database and are available online (Hartman et al. 2009). All specimens are housed at RM, and duplicates have been sent to MONT, MONTU, and other herbaria. We searched all databased records at MONT, MONTU, and RM/USFS (USFS is the National Herbarium of the U.S. Forest Service, integrated with RM; Hartman et al. 2009; MONT 2013; MONTU 2013) from the area for taxa we did not collect as part of this study but were collected by others and personally verified the identification of these specimens. These "historical" taxa are included within the annotated checklist.

We described 19 vegetation types organized into six physiognomic categories based on the dominant vegetation of each type, taking inspiration from the Montana Ecological Systems Field Guide (MTNHP 2012a). These descriptions are based on our field notes, and the species listed in our vegetation type descriptions were the most commonly collected within each type.

We performed two types of analyses to assess the adequacy of our collecting in documenting the actual diversity of vascular plants. The first was a comparison of the environmental conditions and cover types sampled by our collection sites and a set of randomly placed points based on the non-stratified environmental parameter analysis described by Neldner et al. (1995). Using ArcGIS v. 10.0 (ESRI 2011) we classified ranges of three environmental variables across the area: elevation (USGS 2009), average annual precipitation, and average daily minimum temperature (PRISM 2004). We then created a raster file with combinations of these classes and determined how many combinations were sampled by our collection sites and a set of random points within the same accessible lands we collected. We also repeated this analysis using land cover type data from MTNHP (2010) in place of the environmental data.

The second type of analysis used to evaluate our sampling adequacy was a comparison of the vascular plant diversity we observed to estimates of the true diversity present. We used EstimateS v. 9.1 (Colwell 2013) to make taxon accumulation curves by collection days elapsed both chronologically and from 100 randomizations of collecting order using the default settings. For this purpose we used all collections that were definitively identified even if they were eventually discarded for inadequate material. We estimated the total vascular plant diversity using both the non-parametric, asymptote-fitting Michaelis-Menten equation and parametric richness estimators (i.e. based on the number of taxa collected only once or twice) such as the bootstrap, second-order jackknife, and Chao 1 estimators (see Colwell & Coddington 1994 for a review of these methods). We compared these estimates of actual taxon diversity to the number of observed taxa to estimate the percentage of actual taxon diversity documented.

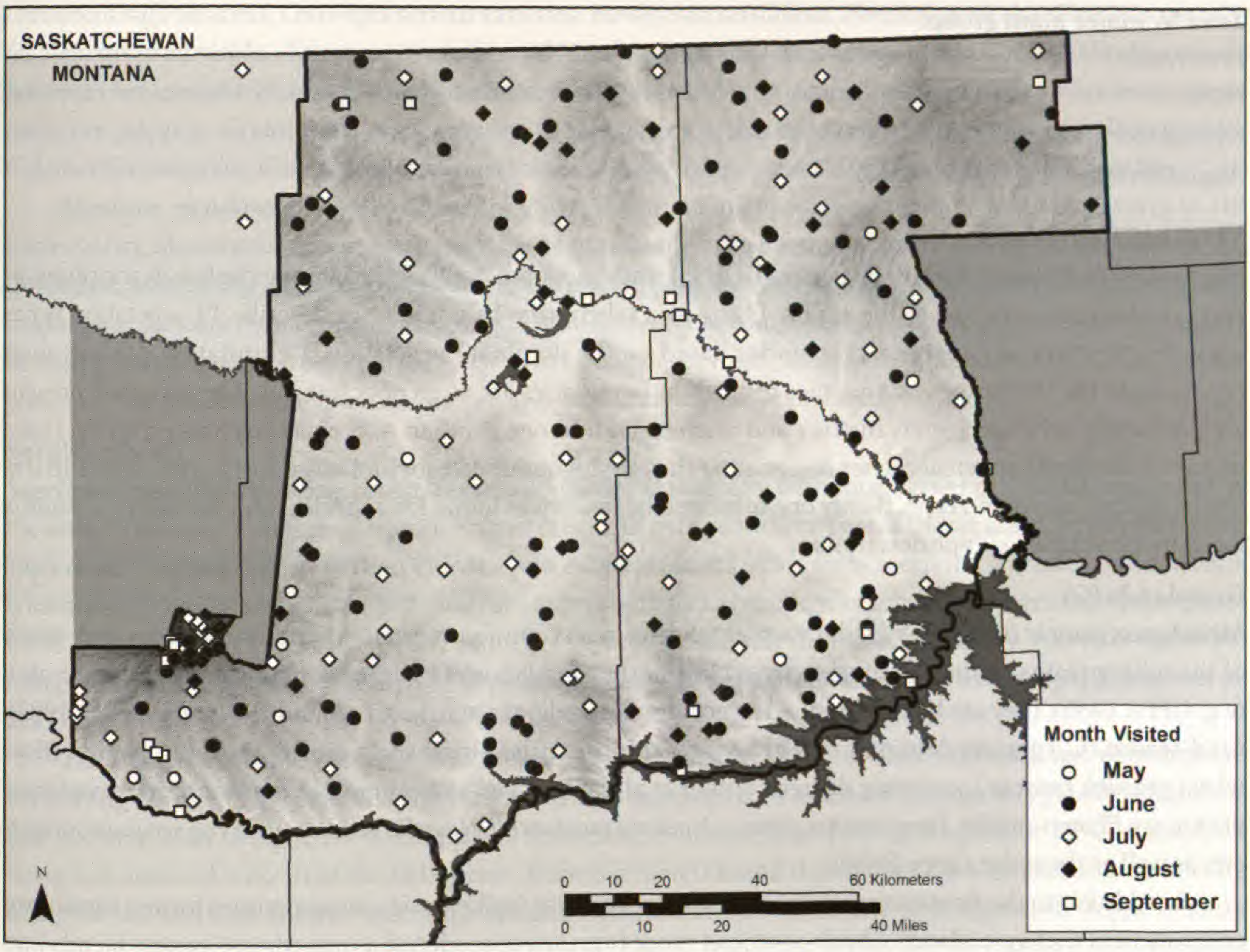

Fig. 2. Collection sites depicted by month visited. Specimens were collected from 308 sites in 2010–2011 primarily in Phillips and Valley counties. The study area is outlined in black.

RESULTS AND DISCUSSION

Results of the inventory are included in the following sections: summary of taxa, vegetation types, taxa of conservation concern, exotic taxa and noxious weeds, newly documented taxa, and sampling adequacy.

Summary of Taxa

We collected 762 unique taxa from 86 vascular plant families. The families with the highest diversity are Asteraceae (134 taxa), Poaceae (111), Fabaceae (55), Brassicaceae (39), and Rosaceae (37). Genera with the greatest number of taxa observed are *Carex* (Cyperaceae; 21 taxa), *Astragalus* (Fabaceae; 19), *Elymus* (Poaceae; 18), *Poa* (Poaceae; 11), and *Potentilla* (Rosaceae; 11). Below is a summary of the plants collected during the study. Seventy "historical" taxa housed at MONT, MONTU, or RM/USFS were located from an additional four families, 22 genera, and 68 species, bringing the total number of unique taxa to 832. Numbers in parentheses below are totals including taxa collected by other workers.

Taxa by taxonomic category:Taxa by special category:

Families	86	(90)
Genera	358	(380)
Species	718	(786)
Infraspecies	43	(45)
Putative hybrids	1	(1)
Unique taxa	762	(832)

Exotic	108	(133)
Percent exotic taxa	14.2	(16.0)
MT noxious weeds	10	(12)
Of conservation concern	15	(20)
New to study area	227	
County records	446	

Taxa by major plant group:

Fern Allies	7	(7)
Ferns	7	(8)
Gymnosperms	7	(7)
Angiosperms	741	(810)

VEGETATION TYPES

Mackie (1970), Roberts (1980), Hansen et al. (1995), and Cooper et al. (2001) are among the few descriptions of plant communities specific to the region. Using data taken from field notes, we describe 19 vegetation types organized into six physiognomic categories based on the dominant vegetation. Delimitation of vegetation types across the landscape is sometimes difficult as boundaries are often not clear-cut. The types we present are not meant to be completely distinct and often blend into one another. Abbreviations for vegetation types consist of an initial uppercase letter designating the physiognomic category followed by two lowercase letters for the unique vegetation type. If only one infraspecific taxon was found for a species, only the species name is listed in the vegetation type description.

Grasslands (G)

Mixedgrass prairie (Gmg).—Mixedgrass prairie is the most common vegetation type, dominating over much of the rolling plains. Although some sources classify the grasslands of eastern Montana as shortgrass prairie (e.g. GPFA 1986), they are better classified as northern mixedgrass prairie (Coupland 1961; Singh et al. 1983). Cool-season (C_3) grasses dominate this mixedgrass prairie with a single short, warm-season (C_4) grass (*Bouteloua gracilis*) present to varying degrees (Singh et al. 1983). Cool-season grasses dominant in mixedgrass prairie are *Elymus smithii*, *Hesperostipa comata*, *Koeleria macrantha*, *Nassella viridula*, and *Poa secunda* subspecies as well as the sedge *Carex filifolia*.

In addition to the dominance of grasses, *Selaginella densa* (spikemoss) can sometimes form a significant component of these grasslands. Shrub cover can range from low to moderate as mixedgrass prairie blends into sagebrush steppe. Shrubs commonly found are *Artemisia cana*, *A. tridentata*, *Juniperus horizontalis*, and *Krascheninnikovia lanata* along with the cactus *Opuntia polyacantha* and the subshrub *A. frigida*. Forb diversity is relatively high in mixedgrass prairie. *Achillea millefolium*, *Allium textile*, *Antennaria* spp., *Astragalus* spp., *Boechera collinsii*, *Collomia linearis*, *Erigeron pumilus*, *Erysimum inconspicuum*, *Hedeoma hispidum*, *Heterotheca villosa*, *Hymenoxys richardsonii*, *Lomatium foeniculaceum*, *Oenothera suffrutescens*, *Packera cana*, *Pediomelum argophyllum*, *Penstemon* spp., *Phlox hoodii*, *Plantago patagonica*, *Ratibida columnifera*, *Sphaeralcea coccinea*, *Vicia americana* var. *minor*, and the exotic *Tragopogon dubius* are commonly found.

The area's flora is more greatly influenced by regions to the west rather than by the eastern edge of the Great Plains (Lavin & Seibert 2011). Grasses of the tallgrass or "true" prairie such as *Andropogon gerardii* Vitman, *Hesperostipa spartea* (Trin.) Barkworth, *Panicum virgatum* L., *Sorghastrum nutans* (L.) Nash, and *Sporobolus heterolepis* (A. Gray) A. Gray (Johnson & Larson 2007) indeed are entirely absent. But to say that the area is little influenced by the Great Plains flora as indicated by Lavin and Seibert (2011) is dependent on how one defines this flora. The Great Plains flora is in all parts recent and adventive, with species colonizing from peripheral ecosystems (GPFA 1986).

A variant of mixedgrass prairie occurs in the north where mesic grasslands on soils derived from fine-grained till are dominated by *Hesperostipa curtiseta* and *Elymus lanceolatus* varieties (Coupland 1961; Cooper et al. 2001). This association will be discussed further with the moist coulee bottom and swale vegetation type.

Upland prairie (Gup).—Well-drained prairie uplands often have a distinctive suite of species in addition to those common on typical mixedgrass prairie. Sandstone outcrops and sandstone-derived soils are often present on uplands since sandstone erodes less easily than shale in this semiarid environment (Jensen & Varnes 1964). Thus many uplands often have sandier soil than surrounding areas. On these uplands, forbs such as *Astragalus gilviflorus*, *Comandra umbellata*, *Cryptantha celosioides*, *C. spiculifera*, *Dalea candida*, *Eriogonum* spp., *Heterotheca villosa*, *Hymenopappus filifolius*, *Hymenoxys richardsonii*, *Lithospermum incisum*, *Lupinus pusillus*,

Oenothera suffrutescens, *Oxytropis sericea* varieties, *Paronychia sessiliflora*, *Penstemon nitidus*, *Physaria spatulata*, *Stenotus armerioides*, *Tetraneuris acaulis*, and *Xanthisma grindelioides* are common. Typical shrubs include *Juniperus horizontalis*, *Krascheninnikovia lanata*, *Rhus trilobata*, *Yucca glauca*, and the subshrub *Artemisia campestris* var. *pacifica*. Graminoids often growing in this habitat are *Achnatherum hymenoides*, *Bouteloua gracilis*, *Calamovilfa longifolia*, *Carex filifolia*, *Elymus spicatus*, *Hesperostipa comata*, and *Schizachyrium scoparium*.

Montane meadows (Gmm).—There are only a few montane meadows found on south exposures in the Little Rocky Mountains. These often have many grassland species found at lower elevations but also have a distinctive assemblage of forbs. Diagnostic forbs include *Balsamorhiza sagittata*, *Delphinium bicolor*, *Drymocallis glabrata*, *Lithospermum ruderale*, *Oxytropis splendens*, and *Solidago mollis*. Some diagnostic graminoids are *Bromus porteri*, *Calamagrostis purpurascens*, *Carex hoodii*, *C. rossii*, *Festuca saximontana*, and the exotic *Poa pratensis*. The shrub *Dasiphora fruticosa* can also be found in these open meadows.

Shrublands (S)

Sagebrush steppe (Sss).—Sagebrush steppe intergrades extensively with mixedgrass prairie, sharing many of the same graminoid and forb species. It is most prevalent in the southern part of the area. Sagebrush (*Artemisia* spp.) cover is dependent in part on climatic and edaphic factors, with areas receiving a greater proportion of winter precipitation and greater soil moisture at depth likely to have higher sagebrush cover than pure grasslands (Knight 1994). Fires also greatly influence sagebrush cover. It may take more than 100 years for Wyoming big sagebrush cover to return to pre-burn levels in eastern Montana sagebrush steppe (Cooper et al. 2011).

There are two primary sagebrush taxa forming sagebrush steppe: *Artemisia tridentata* var. *wyomingensis* (Wyoming big sagebrush) and *A. cana* var. *cana* (silver sagebrush). *Artemisia tridentata* is typically is found on fine-textured soils (Knight 1994) and is at its northeastern limit within the area (McArthur 1999), indeed, we never encountered it north of the Milk River. *Artemisia cana* is found throughout the area and is more tolerant of higher soil moisture than *A. tridentata* (Knight 1994) and as such can often form sagebrush steppe in moist coulees. *Artemisia cana* is also found in sandier soil than *A. tridentata* and is able to resprout after fires and other disturbances unlike *A. tridentata* (Knight 1994).

Ericameria nauseosa var. *nauseosa* is another common shrub in sagebrush steppe along with the subshrubs *Artemisia frigida*, *Atriplex gardneri* var. *gardneri*, *Gutierrezia sarothrae*, and the cactus *Opuntia polyacantha*. Typical graminoids are *Bouteloua gracilis*, *Elymus elymoides* varieties, *E. smithii*, *Hesperostipa comata*, *Koeleria macrantha*, *Nassella viridula*, *Poa secunda* subspecies, and the exotic grass *Bromus japonicus*. Forbs commonly found in sagebrush steppe include *Achillea millefolium*, *Allium textile*, *Antennaria parvifolia*, *Astragalus missouriensis*, *Atriplex argentea*, *Dalea purpurea*, *Erigeron pumilus*, *Grindelia squarrosa*, *Heterotheca villosa*, *Musineon divaricatum*, *Orobanche fasciculata*, *Pediomelum argophyllum*, *Plantago patagonica*, *Ratibida columnifera*, *Senecio integerrimus* var. *scribneri*, *Vicia americana* var. *minor*, and the exotic *Tragopogon dubius*. As in mixedgrass prairie, *Selaginella densa* can form significant ground cover as well.

Juniper steppe/woodland (Sjw).—This vegetation type is transitional between sagebrush steppe and ponderosa pine-juniper woodland, overlapping both considerably. It is found only in the south along the Missouri River Breaks where *Juniperus scopulorum* (Rocky Mountain juniper), *J. horizontalis* (creeping juniper), and their conspecific hybrid, *J. ×fassettii*, occur relatively sparsely on hillsides and coulees. *Juniperus×fassettii* (also known as *J. scopulorum* Sarg. var. *patens* Fassett) is a decumbent shrub intermediate in stature between the parental species that lacks the single-stemmed crown of *J. scopulorum* and the completely prostrate habit of *J. horizontalis* (Adams 2011). Other common shrubs include *Artemisia tridentata* and *Rhus trilobata*.

Greasewood shrubland (Sgs).—Shrublands dominated by *Sarcobatus vermiculatus* (greasewood) are often found toward the bottom of coulees on soils derived from marine shales where there are saline soils and a high water table (MTNHP 2012a). *Artemisia tridentata* is another common shrub in the fine-textured soils of this vegetation type along with subshrubs *Atriplex gardneri* var. *gardneri*, *Gutierrezia sarothrae*, *Suaeda calceoliformis*, and the cactus *Opuntia polyacantha*. The forbs *Atriplex suckleyi*, *Dieteria canescens*, *Grindelia squarrosa*, *Helianthus annuus*, *Iva axillaris*, *Musineon divaricatum*, *Plantago elongata*, *Sphaeralcea coccinea*, *Vicia ameri-*

cana var. *minor* are typically found along with exotics *Melilotus officinalis*, *Polygonum aviculare*, and *Tragopogon dubius*. Common grasses include *Bouteloua gracilis*, *Distichlis spicata*, *Elymus elymoides* var. *elymoides*, *E. smithii*, *Hordeum jubatum* ssp. *intermedium*, and the exotic grass *Bromus japonicus*. Sagebrush steppe and juniper steppe/woodland often intergrade into these greasewood shrublands from upslope.

Forests and Woodlands (F)

Thicket and woody draw (Ftw).—In steep coulees there is enough moisture to support thickets primarily of shrubs, especially Prunus virginiana, Rhus trilobata, and Shepherdia argentea but also Amelanchier alnifolia, Cornus sericea, Juniperus spp., Ribes spp., Rosa woodsii, Symphoricarpos occidentalis, and Toxicodendron rydbergii. In the steepest, moistest coulees, trees such as Acer negundo var. interius, Fraxinus pensylvanica, Juniperus scopulorum, and Populus deltoides can be found. Typical grasses in these thickets are Elymus canadensis, E. trachycaulus var. trachycaulus, Nassella viridula, Piptatherum micranthum, and exotics Bromus inermis and Poa pratensis. Forbs such as Astragalus agrestis, Campanula rotundifolia, Geum triflorum, Glycyrrhiza lepidota, Maianthemum stellatum, Parietaria pensylvanica, Solidago missouriensis, and Urtica dioica are often found along with exotics Camelina microcarpa and Fallopia convolvulus. Wooded draws with Fraxinus pensylvanica are presently experiencing reduced seedling recruitment and have been declining in quality across eastern Montana due to the effects of overgrazing and the invasion of exotic grasses such as Bromus inermis and Poa pratensis (Lesica & Marlow 2013).

Riparian cottonwood forest (Frc).—Similar to woody draws and thickets, these riparian forests dominated by *Populus deltoides* (cottonwood) are found along the flood plains of the Milk and Missouri rivers and a few larger creeks. Other trees sometimes found in these riparian forests are *Acer negundo* var. interius, *Fraxinus pensylvanica*, and *Salix amygdaloides*, along with the exotic tree *Elaeagnus angustifolia*. Typical shrubs are *Prunus virginiana*, *Rosa woodsii*, *Salix eriocephala* var. *famelica*, *S. exigua* ssp. *interior*, *Symphoricarpos occidentalis*, and the subshrub *Artemisia dracunculus*. Fluctuating water levels and livestock disturb these forests so weedy grasses such as exotics *Bromus inermis*, *Eragrostis cilianensis*, *Setaria viridis*, and natives *Echinochloa muricata* and *Panicum capillare* are often found along with weedy forbs including exotics *Euphorbia esula* varieties and *Kochia scoparia*. Also commonly found are *Artemisia ludoviciana*, *Chamaesyce glyptosperma*, *Glycyrrhiza lepidota*, and *Solidago gigantea*. In many of these forests, human alteration of hydrology has resulted in highly altered, old cottonwood stands with limited regeneration since high water events are necessary for the recruitment of new seedlings (Auble & Scott 1998). Flooding during 2011, however, resulted in the establishment of many new cottonwood seedlings on the banks of the Milk and Missouri rivers.

Ponderosa pine-juniper woodland (Fpj).—This habitat occurs only in parts of the Missouri River Breaks on steep drainages. The upper canopy is typically fairly open and composed of *Pinus ponderosa* (ponderosa pine), although *Pseudotsuga menziesii* (Douglas fir) may also be found on some of the steepest north exposures in southern Phillips County. Typically there is also a thick understory of junipers, both *Juniperus scopulorum* and *J.* ×*fassettii*. Surrounding vegetation types like sagebrush steppe and juniper steppe/woodland heavily influence ponderosa pine-juniper woodland vegetation. *Artemisia tridentata*, *Juniperus communis*, *Ribes cereum*, *Rhus trilobata*, and *Symphoricarpos occidentalis* are common shrubs. Graminoids such as *Achnatherum hymenoides*, *Carex inops*, *Elymus smithii*, *E. spicatus*, *Nassella viridula*, *Poa secunda* subspecies, and the exotic grass *Bromus japonicus* are typically found. *Achillea millefolium*, *Parietaria pensylvanica*, *Pediomelum argophyllum*, *Phacelia linearis*, *Thermopsis rhombifolia* var. *rhombifolia*, and the exotic *Tragopogon dubius* are common forbs. Many of these woodlands and surrounding sagebrush steppe have a heavy cover of the exotic *Melilotus officinalis*, which was often seeded by land managers in revegetation projects even though it can be highly invasive on the Northern Great Plains (Lesica & DeLuca 2000). In addition to shading out native vegetation, *M. officinalis* may allow other non-native plants to outcompete native ones by enriching soils with nitrogen (Lesica & DeLuca 2000).

Montane ponderosa pine forest (Fpp).—These forests are found only in the Little Rocky Mountains in dry areas at low elevations. Montane ponderosa pine forests occur from about 1,130 to 1,310 m (3,700 to 4,300 ft) where they begin to transition into lodgepole pine forests. Above these elevations, ponderosa pine is more

scarce and usually only on sunny, south exposures. Ponderosa pine is at the northern edge of its range within the area. In the Cypress Hills (in Canada) and the Sweetgrass Hills, only about 100 km (60 mi) further north than the Little Rockies, ponderosa pine is absent, apparently because the climate is too cold (Breitung 1954; Thompson & Kuijt 1976; USGS 1999).

Pinus ponderosa is the dominant tree in these forests with *Juniperus scopulorum* present in the understory. The understory also includes such shrubs as *Arctostaphylos uva-ursi*, *Berberis repens*, and *Juniperus communis* along with the subshrub *Artemisia campestris* var. *pacifica*. Representative grasses are *Danthonia spicata*, *Elymus albicans*, *E. trachycaulus* var. *trachycaulus*, and the exotic *Poa compressa*. The suite of forbs found in these montane forests is quite different from those found in the ponderosa pine-juniper woodlands of the Missouri River Breaks. *Anemone multifida*, *A. patens*, *Allium cernuum*, *Cerastium arvense*, *Cirsium undulatum*, *Fragaria virginiana*, *Gaillardia aristata*, *Helianthus pauciflorus*, *Maianthemum stellatum*, *Monarda fistulosa*, *Pterospora andromedea*, *Solidago simplex*, and *Viola adunca* are typical forbs.

Montane mixed conifer forest (Fmc).—This forest type is found in the Little Rocky Mountains on mesic slopes at middle elevations. Tree canopy is made up of a mixture of the conifers *Pinus contorta* (lodgepole pine), *P. ponderosa*, and *Pseudotsuga menziesii* along with the deciduous tree *Populus tremuloides* (quaking aspen). Common shrubs are *Arctostaphylos uva-ursi*, *Berberis repens*, *Juniperus communis*, and *Shepherdia canadensis*. Representative grasses found in these forests are *Danthonia spicata*, *Elymus spicatus*, *Poa interior*, and exotics *E. repens* and *Phleum pratense*. Typical forbs include *Achillea millefolium*, *Campanula rotundifolia*, *Clematis occidentalis*, *Gaillardia aristata*, *Galium boreale*, *Linnaea borealis*, *Maianthemum racemosum*, *Moehringia lateriflora*, *Monarda fistulosa*, *Osmorhiza chilensis*, *Prosartes trachycarpa*, *Pterospora andromedea*, and the exotic *Medicago lupulina*.

Lodgepole pine forest (Flp).—Lodgepole pine forests are found in the Little Rockies in dry areas at high elevations. These forests typically have a closed canopy and an understory depauperate of species. Moderate disturbance can add some diversity to these forests, but following fires, thick "doghair" stands of young trees sprout from serotinous cones (Knight 1994). Such stands are common in the Little Rockies. Mountain pine beetle infestations in these and other forests in the Little Rocky Mountains are minimal at this time. Shrubs found in lodgepole pine forests are *Ceanothus velutinus*, *Juniperus communis*, *Rosa nutkana*, *Salix scouleriana*, and *Shepherdia canadensis*. Other species commonly found include *Galium boreale*, *Linnaea borealis*, *Orthilia secunda*, *Pterospora andromedea*, *Spiraea betulifolia*, and *Thermopsis rhombifolia* var. *rhombifolia*. There are no subalpine forests found in the Little Rockies. *Picea engelmannii* Parry ex Engelm. (Engelmann spruce) has been reported in the nearby Bearpaw Mountains (USGS 1999), which rise to a maximum elevation of 2,108 m (6,917 ft), nearly 365 m (1,200 ft) higher than the Little Rockies.

Montane riparian forest (Fmr).—This forest type is found along moist creek bottoms in the Little Rocky Mountains, and we have included wetland species found in and along mountain creeks under this vegetation type. Mixed conifers (*Pinus contorta*, *P. ponderosa*, and *Pseudotsuga menziesii*) form the canopy with a thick understory of the deciduous trees *Betula papyrifera* (paper birch) and *Populus tremuloides* and the shrubs *Amelanchier alnifolia*, *Cornus sericea*, *Juniperus communis*, *Prunus virginiana*, *Ribes* spp., *Salix bebbiana*, and *Shepherdia canadensis*. Typical grasses are *Bromus richardsonii*, *Poa palustris*, and exotics *B. inermis*, *Phleum pratense*, and *Poa pratensis*. Common forbs include *Achillea millefolium*, *Actaea rubra*, *Agrimonia striata*, *Clematis occidentalis*, *Equisetum arvense*, *Galium boreale*, *G. triflorum*, *Geranium richardsonii*, *Heracleum maximum*, *Hieracium umbellatum*, *Linnaea borealis*, *Maianthemum racemosum*, *Mimulus guttatus*, various orchids, *Prosartes trachycarpa*, *Pyrola asarifolia*, *Sanicula marilandica*, *Spiraea betulifolia*, *Symphyotrichum ciliolatum*, *Viola canadensis*, and the exotic *Cirsium vulgare*. The presence of paper birch in the Little Rockies suggests the presence of boreal forests in the region following Pleistocene glaciations. Most of the flora of the Little Rockies, however, is more indicative of a cordilleran influence as in the Sweetgrass Hills (Thompson & Kuijt 1976) and to a lesser extent the Cypress Hills (Breitung 1954).

Wetlands (W)

Moist coulee bottom and swale (Wcb).—Some prairie species are most typically found in moist coulee bottoms and swales. This habitat also grades into thickets and wooded coulees if there is enough moisture to support

more woody vegetation and into persistent wetlands if there is surface water. Common forbs in moist coulee bottoms and swales include *Achillea millefolium*, *Arnica fulgens*, *A. sororia*, *Artemisia ludoviciana*, *Cerastium arvense*, *Geum triflorum*, *Glycyrrhiza lepidota*, *Grindelia squarrosa*, *Orthocarpus luteus*, *Potentilla* spp., *Thermopsis rhombifolia* var. *rhombifolia*, *Veronica peregrina*, and *Zigadenus venenosus* along with exotics *Draba nemorosa*, *Thlaspi arvense*, and *Tragopogon dubius*. Common graminoids are *Carex brevior*, *C. praegracilis*, *Hordeum jubatum* subspecies, *Juncus arcticus*, *Nassella viridula*, and the exotic *Poa pratensis*. The shrubs *Artemisia cana*, *Juniperus horizontalis*, *Rosa woodsii*, and *Symphoricarpos occidentalis* can also be found.

Distinct from moist coulee bottoms and swales, vernal pools with seasonally standing water can be found in otherwise flat topography. *Eleocharis acicularis*, *E. palustris*, *Gnaphalium palustre*, *Myosurus minimus*, *Navarretia saximontana*, *Plagiobothrys leptocladus*, *P. scouleri*, and *Veronica peregrina* are commonly found in vernal pools. Several of the taxa of conservation concern we found grow in these vernal pools as well.

The coulee bottoms and mesic grasslands in the north, particularly in northeastern Valley County, seem to be indicative of vegetation types more common to the north in Canada. In the Opheim Hills and to the east, the shrubs *Dasiphora fruticosa* and *Elaeagnus commutata* can also be found in moist swales. *Populus tremuloides*, rare on the plains of eastern Montana but more common further north in Canada (Coupland 1961; Cooper et al. 2001), can be found in some of the coulees of the Opheim Hills and northeastern Phillips County as well. A few species found nowhere else were present in these moist habitats: *Carex obtusata*, *Fragaria vesca*, *Geranium viscosissimum*, *Primula pauciflora*, *Viola nephrophylla*, and *Zizia aptera*. Many of these species are more common on the Canadian prairies further north (Budd 1979). Other species were only encountered elsewhere in the Little Rockies including *Carex bebbii*, *C. sprengelii*, *Delphinium bicolor*, *Heracleum maximum*, *Shepherdia canadensis*, and *Viola canadensis*. The grasses *Elymus lanceolatus* varieties and *Hesperostipa curtiseta* were also frequently found in these locations. *Festuca hallii*, the principal grass of the fescue prairies of Canada (Coupland 1961), was found only once in the study in northeastern Valley County just a few miles south of Canada. This area receives slightly greater precipitation and is generally colder than the rest of the area (PRISM 2004).

The *Hesperostipa curtiseta-Elymus lanceolatus* grasslands found in northeastern Valley County are much more common in Canada than in the U.S. However, they were once more prevalent in both countries before such sites, which are well suited to grain production, were put under cultivation (Cooper et al. 2001). Indeed, most of the lands east of Opheim are in cultivation and privately owned. A sizable expanse of this prairie association in a large area of Montana State Trust Lands along Dry Fork Creek in northern Valley County represents one of, if not the best, remaining of its kind in the U.S. (Cooper et al. 2001).

Persistent wetland (Wpw).—Most persistent wetlands are located around small reservoirs although they also occur along large creeks and small pools in creek beds where open water persists throughout the growing season. Around the periphery of wetlands, which may be submerged in the spring and early summer but are often dry by autumn, graminoids such as *Beckmannia syzigachne*, *Carex* spp., *Echinochloa muricata*, *Eleocharis acicularis*, *E. palustris*, *Hordeum jubatum* subspecies, *Juncus arcticus*, *Poa palustris*, and the exotic grass *Polypogon monspeliensis* are common along with the forbs *Conyza canadensis*, *Glycyrrhiza lepidota*, *Lycopus asper*, *Mentha arvensis*, *Rumex* spp., exotic *Sonchus arvensis* and the noxious weed *Cirsium arvense*. Common shrubs on the periphery of wetlands are *Rosa woodsii* and *Salix exigua* ssp. *interior*. Occasionally the trees *Populus deltoides* and *Salix amygdaloides* may occur as well. Emergent aquatic plants typically growing in standing water throughout the growing season are *Alisma gramineum*, *A. triviale*, *Bolboschoenus fluviatilis*, *B. maritimus*, *Limosella aquatica*, *Persicaria amphibia*, *P. lapathifolia*, *Sagittaria cuneata*, *Schoenoplectus* spp., *Typha angustifolia*, and *T. latifolia*. Common submerged aquatics are *Ceratophyllum demersum*, *Potamogeton* spp., *Ranunculus aquatilis*, and *Stuckenia pectinata*.

Alkaline wetland (Wal).—Many wetlands are alkaline at least to some extent because soils in most of the area are derived from marine shales. Many species found in freshwater wetlands are also found in alkaline wetlands but the most alkaline typically have a unique assemblage including *Distichlis spicata*, *Glaux maritima*, *Hordeum jubatum* subspecies, *Iva axillaris*, *Juncus arcticus*, *Puccinellia nuttalliana*, *Salicornia rubra*, *Spergularia marina*, *Triglochin maritima*, the subshrub *Suaeda calceoliformis* and the exotic *Polygonum aviculare*.

Sparsely vegetated alkaline pan areas are also common. These pan areas are formed above high points on the shale-till boundary beneath the soil surface. Salts from marine shales accumulate here and cause the formation of natric horizons in the subsoil, which greatly reduces infiltration of precipitation (Munn & Boehm 1983). Few plants can thrive in these water-stressed, alkaline conditions, so plant cover is very sparse with low diversity. *Atriplex suckleyi*, *Dieteria canescens*, *Distichlis spicata*, *Elymus smithii*, *Hordeum jubatum* subspecies, *Iva axillaris*, *Monolepis nuttalliana*, *Oenothera cespitosa*, *Puccinellia nuttalliana*, the exotic *Polygonum aviculare*, and the subshrub *Atriplex gardneri* var. *gardneri* are among the few species typically encountered.

Sparsely Vegetated (V)

Badlands (Vbl).—Badlands are common where marine shales are exposed. When wetted, these badlands form slick, alkaline clay that cracks extensively upon drying and erodes so rapidly that little vegetation can be established. The few species that can survive on badlands are often ruderal and tolerant of alkalinity. These include *Atriplex argentea*, *A. suckleyi*, *Eriogonum pauciflorum*, *Iva axillaris*, *Monolepis nuttalliana*, *Oenothera cespitosa*, *Penstemon nitidus*, and exotics *Conringia orientalis* and *Polygonum aviculare* occasionally with subshrubs *Atriplex gardneri* var. *gardneri*, *Suaeda calceoliformis*, and the shrub *Sarcobatus vermiculatus*.

Shale dunes, somewhat similar to badlands but less common, are found especially in the north in Bitter Creek WSA and the Frenchman Creek valley. These dunes are formed by the wind when shale weathers into sand-sized particles or small, thin flakes rather than clay minerals. *Juniperus horizontalis* typically stabilizes these dunes. Other species commonly found are *Artemisia longifolia*, *Eriogonum pauciflorum*, *Oenothera cespitosa*, *Rosa* spp., *Stephanomeria runcinata*, and *Thermopsis rhombifolia* var. *rhombifolia*.

Rock outcrops and talus (Vot).—The Little Rocky Mountains have areas of both granitic and carbonate rock outcrops. Chamerion angustifolium var. angustifolium, Cheilanthes feei, Draba cana, Erigeron compositus, Eriogonum ovalifolium var. purpureum, Minuartia rubella, Poa glauca, Sedum lanceolatum, Townsendia hookeri, and Woodsia oregana are among the herbaceous species found on these outcrops. The shrubs Dasiphora fruticosa and Ribes cereum can be found as well.

There are also several large areas of sparsely vegetated talus fields in the Little Rockies. *Ceanothus velutinus*, *Chamerion angustifolium* var. *canescens*, *Prunus pensylvanica*, *Ribes cereum*, *R. oxyacanthoides* var. *oxyacanthoides*, and *Rubus idaeus* are typically found on this talus.

Disturbed (D)

There are many disturbed habitats covered by ruderal forbs and grasses (many are invasive). These are primarily found along roadsides but also in dry reservoir beds, on reservoir dams, and in reseeded fields. Areas disturbed by natural action such as fires, flooding, and animal burrows have many of the same species. Typical exotic forbs of these habitats include *Alyssum desertorum*, *Camelina microcarpa*, *Descurainia sophia*, *Kochia scoparia*, *Lactuca serriola*, *Lappula occidentalis*, *Medicago lupulina*, *M. sativa*, *Melilotus officinalis*, *Polygonum aviculare*, *Salsola tragus*, *Thlaspi arvense*, *Tragopogon dubius*, and the noxious weed *Convolvulus arvensis*. Natives *Chamaesyce* spp., *Chenopodium berlandieri*, *Grindelia squarrosa*, *Helianthus annuus*, *Lepidium densiflorum* varieties, *Monolepis nuttalliana*, *Plantago patagonica*, *Polygonum achoreum*, and *Verbena bracteata* are common in disturbed habitats as well. Typical weedy grasses are the exotics *Agropyron cristatum* varieties, *Bromus inermis*, *B. japonicus*, *B. tectorum*, *Eragrostis cilianensis*, *Poa pratensis*, and natives *Hordeum jubatum* subspecies and *Munroa squarrosa*.

A few species were only found planted and persisting at old homesteads and other such sites. These are *Caragana arborescens*, *Cotoneaster lucidus*, *Lonicera tatarica*, *Malus pumila*, *Ulmus americana*, and *U. pumila*. *Syringa vulgaris* L. was also present but never collected at such sites. Many of the "historical" taxa added to the checklist were collected in disturbed areas including farm fields, gardens, and lawns. Over 35 percent of the historical taxa added to the checklist are exotic to Montana while about 14 percent of the taxa we collected are exotic (Mincemoyer 2012).

Taxa of Conservation Concern

Fifteen taxa of conservation concern were documented from 34 sites. These taxa are tracked by the Montana

Natural Heritage Program with state ranks of S1, S2, or S3 or are listed as sensitive by the Bureau of Land Management (MTNHP 2012b). These taxa are indicated by a diamond (♦) in the annotated checklist and listed alphabetically below.

Ammannia robusta (Lythraceae) was found in Valley County in a reservoir and adjacent mudflat. Voucher: *Nelson 81384.*

Anagallis minima (Myrsinaceae) was found in Phillips and Valley counties in vernal pools. Vouchers: *Charboneau 2486, 7921.*

Bacopa rotundifolia (Plantaginaceae) was found in Phillips County on the edge of a reservoir. Voucher: *Charboneau 9535.*

Botrychium hesperium (Ophioglossaceae) was found in Phillips County in a rocky disturbed area in lodgepole pine forest. Voucher: *Charboneau 2120.*

Carex scoparia var. **scoparia** (Cyperaceae) was found in Phillips County in a juniper thicket in the Missouri River Breaks and in a montane meadow. Vouchers: *Charboneau 2298, 7690.*

Elodea bifoliata (Hydrocharitaceae) was found in Phillips County floating in reservoirs. Vouchers: *Charboneau 9431, 9516, 9541.*

Phlox andicola (Polemoniaceae) was found in Phillips County in sagebrush steppe. Voucher: *Charboneau 5069.*

Physaria brassicoides (Brassicaceae) was found in Phillips County in a montane meadow. Voucher: *Charboneau 4812.*

Physaria ludoviciana (Brassicaceae) was found in Valley County in mixedgrass prairie. Vouchers: *Charboneau 4862; Nelson 82012.*

Plagiobothrys leptocladus (Boraginaceae) was found in Phillips and Valley counties in vernal areas. Vouchers: *Charboneau 1373b, 5791, 6144, 6870, 7209; Nelson 80119, 80180, 80542, 81590.*

Psilocarphus brevissimus var. **brevissimus** (Asteraceae) was found in Phillips County in a vernal area. Voucher: *Charboneau 7286a.*

Ranunculus hyperboreus (Ranunculaceae) was found in Valley County floating in a creek. Voucher: *Charboneau 2462.*

Senecio eremophilus var. **eremophilus** (Asteraceae) was found in Phillips County in montane disturbed areas. Vouchers: *Charboneau 2141, 9167; Nelson 81011.*

Sphenopholis intermedia (Poaceae) was found in Phillips County in mixed conifer forest. Voucher: *Charboneau 2199.*

Suckleya suckleyana (Amaranthaceae) was found in Valley County in dried reservoir bottoms and shores. Vouchers: *Charboneau 2736, 3354, 3843, 3860; Nelson 81378.*

Five additional taxa of conservation concern are known from the area though "historical" records: *Mentzelia nuda* (Loasaceae), *Penstemon grandiflorus* (Plantaginaceae), *Phacelia thermalis* (Boraginaceae), *Potentilla plattensis* (Rosaceae), and *Schoenoplectus heterochaetus* (Cyperaceae).

Exotic Taxa and Noxious Weeds

We collected 108 taxa exotic to Montana (Mincemoyer 2012), comprising 14.2 percent of the 762 taxa we collected. These taxa are indicated in the annotated checklist by an asterisk (*). Nine species (10 taxa) of the 32 species recognized as noxious weeds in Montana (MNWP 2010) were documented. These were *Acroptilon repens*, *Centaurea diffusa*, *C. stoebe*, *Cirsium arvense*, *Convolvulus arvensis*, *Cynoglossum officinale*, *Euphorbia esula* varieties, *Leucanthemum vulgare*, and *Tamarix chinensis*. In the annotated checklist these taxa are indicated by a circle (●). The most widespread and common of these noxious weeds are *Euphorbia esula* varieties and *Cirsium arvense*. Two Montana regulated plants (priority three weeds; MNWP 2010) were also found: *Bromus tectorum* and *Elaeagnus angustifolia*. Twenty-five of the 70 "historical" taxa added to the checklist (35.7 percent) are exotic to Montana (Mincemoyer 2012). Among these additional taxa are two Montana noxious weeds (MNWP

2010): *Lepidium latifolium* and *Tanacetum vulgare*. With the addition of the "historical" taxa, 16.0 percent of the taxa included in the annotated checklist are exotic (Mincemoyer 2012).

Newly Documented Taxa

The area's vascular flora was previously poorly documented. We collected 227 taxa and 201 species that had previously been undocumented (GPFA 1977; Hartman et al. 2009; Lesica 2012; USDA 2012; Kartesz 2013; MONT 2013; MONTU 2013). This accounts for 29.8 percent of the 762 taxa we collected. Only 8.8 percent of these 227 taxa are exotic to Montana (Mincemoyer 2012) indicating that these newly documented taxa predominantly are not newly introduced to the area. Of the 12,768 specimens we collected, 446 or more than one in every 29 collections are county records in either Phillips County or Valley County. On average we collected over four county records per person-day in the field.

Sampling Adequacy

GIS analyses.—In our assessment of the sampling adequacy of environmental conditions by our collection sites, we found that our sites did nearly as well as a set of random points. There were 66 combinations of elevation, average annual precipitation, and average daily minimum temperature classes within the lands accessible for collecting. Our actual collection sites were located in 42 of these combinations while a random set of the same number of points was located in 44 combinations. Our collection sites missed combinations comprising 2.2 percent of accessible lands, while the random points missed combinations totaling 1.1 percent.

While our collection sites sampled nearly as well as random points in environmental conditions, our collection sites outperformed random points in sampling land cover types. Thirty-nine land cover types are reported within accessible lands (MTNHP 2010). These are the same types described in the Montana Ecological Systems Field Guide (MTNHP 2012a). Our collection sites sampled 25 cover types, while the set of random points was only in 15. Our collection sites missed cover types totaling 1.1 percent of accessible lands, while random sites missed cover types making up 2.3 percent.

In both analyses, the frequency of collection sites and random points for the most part mirrored the frequency of environmental class combinations and land cover types of accessible lands, with important exceptions. Our actual sites oversampled rare combinations and cover classes such as those found in the Little Rocky Mountains while undersampling the most common combinations and classes. This allowed us to better document all of the taxa found in rare habitats. Random points also have the disadvantage of often being further from a road or trail than our actual collection sites.

Taxon accumulation curves.—Figure 3 shows the taxon accumulation curve with collecting days added in chronological order. The number of taxa collected levels off in the second year of the inventory as few new taxa were encountered in May and June 2011, although almost 100 were encountered for the first time in July and August 2011. In total 630 taxa (almost 83 percent) were encountered during the first field season, and an additional 132 were collected for the first time during the second field season.

Figure 4 shows the taxon accumulation curve averaged from 100 randomizations of the order of collecting days. The curve levels off fairly well with 90 percent of observed taxon richness encountered by about 60 of 102 collecting days. The asymptote of the species accumulation curve as predicted by the Michaelis-Menten equation (see Colwell and Coddington 1994) reaches 797 taxa, only 35 more than we observed. Parametric estimators gave higher estimates of diversity: the bootstrap estimator predicted 829 taxa, the Chao 1 estimator 885 taxa, and the second-order jackknife estimator 965 taxa. The addition of 70 "historical" taxa to the checklist brings the total number of known taxa to 832, greater than predicted by the Michaelis-Menten equation and the bootstrap estimator based on our collections. Many of the "historical" taxa added were collected in habitats that we did not focus our efforts on such as lawns, gardens, and cultivated fields, which may explain this discrepancy. Based on the addition of these "historical" taxa and our estimates of the taxon diversity present in the area, we collected between 79 and 91.6 percent of the taxa growing in the area.

Our estimate of the actual diversity documented and our analyses of the environmental conditions and

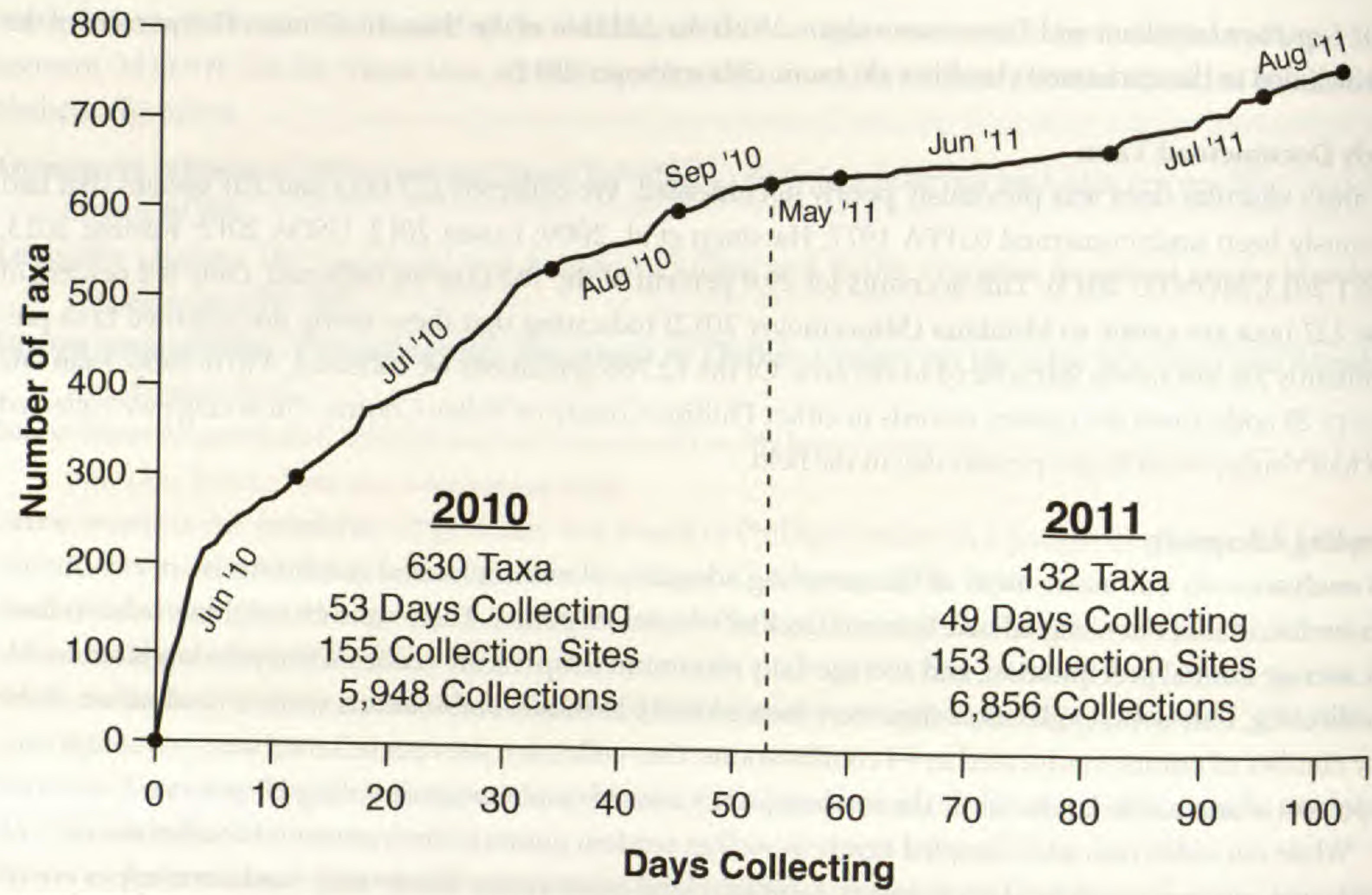

Fig. 3. Taxa accumulated by days collecting in chronological order. In total 762 taxa were collected: 630 during 2010 and an additional 132 for the first time in 2011. Data generated using EstimateS (Colwell 2013).

land cover types sampled by collection sites show we performed adequately in documenting the diversity of vascular plants. Because of the number of taxa documented for the first time in July and August of the second field season and the relatively short time spent collecting in September, the late summer and early fall likely would be the most worthwhile part of the growing season for further collecting.

CONCLUSIONS

This inventory has greatly expanded the floristic knowledge of a 23,191 sq km (8,954 sq mi) area of northeastern Montana. Approximately one in every 29 collections made (446 of 12,768) were county records in either Phillips County or Valley County, and about 30 percent of the taxa we documented were previously unknown from the area. In total, we collected 762 vascular plant taxa from 86 families, an estimated 79–92 percent of the actual vascular plant diversity present in the area. The addition of 70 "historical" taxa brings the total number of unique taxa from the area to 832. This study demonstrates there is still much to be learned about the flora of many parts of the contiguous United States.

ANNOTATED CHECKLIST

The checklist is organized by major groups of vascular plants (fern allies, ferns, gymnosperms, and angiosperms), then alphabetically by family and species. Nomenclature follows that of the RM Plant Specimen Database (Hartman et al. 2009). The reader is referred to the synonymized checklist in USDA (2012) if there is any confusion. Collection data are available online at http://www.rmh.uwyo.edu. Below is a key to the abbreviations and symbols used with individual taxa. The format of each listing is as follows: *Taxon* Authority **(number of collections)** COUNTY; elevation; Vegetation type. Listings of "historical" taxa collected by other workers use the following format: *Taxon* Authority; *Collector's name and number* (HERBARIUM); COUNTY.

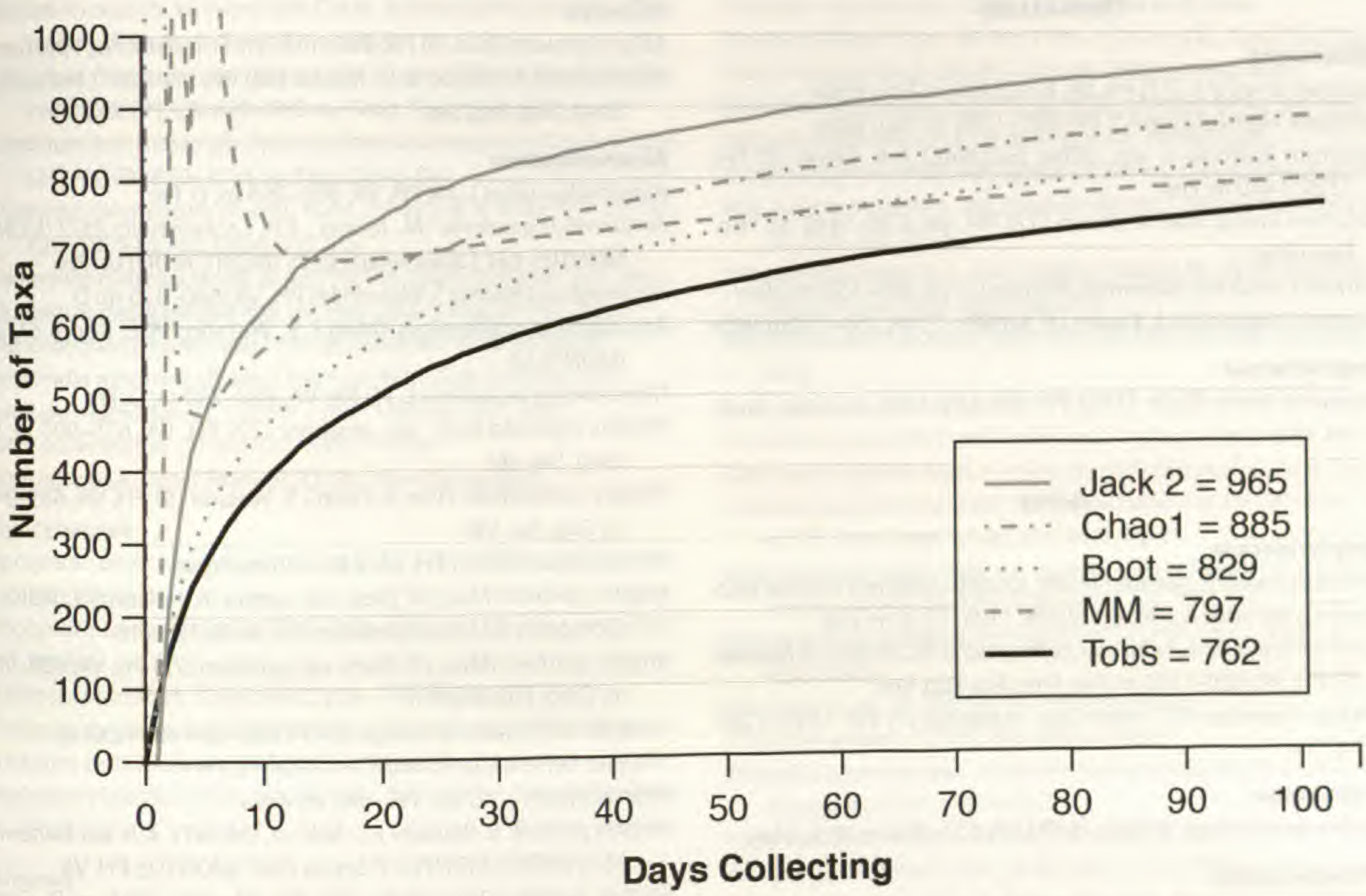

FIG. 4. Average taxa accumulated from 50 randomizations of collecting day order with estimators of taxon diversity. The number of taxa estimated or observed follow these abbreviations: Jack2 = 2nd order jackknife estimator, Chao1 = Chao 1 estimator, Boot = bootstrap estimator, MM = Michaelis-Menten estimator, Tobs = taxa observed. Data generated using EstimateS (Colwell 2013).

County abbreviations:

PH	Phillips	**VA**	Valley

Habitat Types:

D	Disturbed	**Gup**	Upland prairie
Flp	Lodgepole pine forest	**Sgs**	Greasewood shrubland
Fmc	Montane mixed conifer forest	**Sjw**	Juniper steppe/woodland
Fmr	Montane riparian forest	**Sss**	Sagebrush steppe
Fpj	Ponderosa pine-juniper woodland	**Vbl**	Badlands
Fpp	Montane ponderosa pine forest	**Vot**	Rock outcrops and talus
Frc	Riparian cottonwood forest	**Wal**	Alkaline wetland
Ftw	Thicket and wooded coulee	**Wcb**	Moist coulee bottom and swale
Gmg	Mixedgrass prairie	**Wpw**	Persistent wetland
Gmm	Montane meadow		

Symbols preceding taxa:

*	Taxon exotic to Montana
●	Montana noxious weed
♦	Taxon of conservation concern
×	Putative hybrid

FERN ALLIES

Equisetaceae

Equisetum arvense L. (13) PH, VA; 670–1395 m; Fmr, Wpw
Equisetum ×ferrissii Clute (3) PH; 685–1395 m; Fmr, Wpw
Equisetum hyemale L. var. *affine* (Engelm.) A.A. Eaton (5) PH; 1220–1440 m; Fmr
Equisetum laevigatum A. Braun (12) PH, VA; 670–1440 m; Fpp, Ftw, Gmg
Equisetum ×mackaii (Newman) Brichan (1) VA; 680–750 m; Wpw
Equisetum ×nelsonii (A.A. Eaton) J.H. Schaffn. (1) VA; 750–770 m; Wcb

Selaginellaceae

Selaginella densa Rydb. (118) PH, VA; 635–1645 m; Gmg, Gup, Sss, Wcb

FERNS

Dryopteridaceae

Cystopteris fragilis (L.) Bernh. (14) PH, VA; 680–1645 m; Fmr, Ftw, Wcb
Dryopteris filix-mas (L.) Schott (2) PH; 1195–1350 m; Fmr
Woodsia oregana D.C. Eaton var. *cathcartiana* (B.L. Rob.) C.V. Morton (9) PH, VA; 620–1735 m; Flp, Fmc, Fpj, Fpp, Vot
Woodsia scopulina D.C. Eaton ssp. *scopulina* (1) PH; 1195–1230 m; Fmc

Marsileaceae

Marsilea vestita Hook. & Grev. (4) PH, VA; 650–830 m; Wcb, Wpw

Ophioglossaceae

♦ *Botrychium hesperium* (Maxon & R.T. Clausen) W.H. Wagner & Lellinger (1) PH; 1620–1675 m; Flp

Pteridaceae

Cheilanthes feei T. Moore (7) PH; 1195–1440 m; Vot
Pellaea glabella Mett. ex Kuhn var. *occidentalis* (E.E. Nelson) Butters; *P. Lesica 3159* (MONTU); PH

GYMNOSPERMS

Cupressaceae

Juniperus communis L. var. *depressa* Pursh (52) PH, VA; 675–1740 m; Flp, Fmc, Fmr, Fpj, Fpp, Ftw
Juniperus ×fassettii B. Boivin (23) PH, VA; 620–1645 m; Fpj, Ftw, Sjw, Sss
Juniperus horizontalis Moench (90) PH, VA; 655–1685 m; Ftw, Gmg, Gup, Sjw, Sss, Wcb
Juniperus scopulorum Sarg. (63) PH, VA; 620–1485 m; Fpj, Fpp, Ftw, Gup, Sjw, Sss, Wcb

Pinaceae

Pinus contorta Douglas ex Loudon var. *latifolia* Engelm. (16) PH; 1245–1740 m; Flp, Fmc, Fmr
Pinus ponderosa C. Lawson & P. Lawson var. *scopulorum* Engelm. (44) PH, VA; 620–1735 m; Fmc, Fmr, Fpj, Fpp
Pseudotsuga menziesii (Mirb.) Franco var. *glauca* (Beissn.) Franco (35) PH; 830–1740 m; Fmc, Fmr, Fpj

ANGIOSPERMS

Adoxaceae

Viburnum edule (Michx.) Raf.; *C. Doll s.n.* (MONT); PH

Alismataceae

Alisma gramineum Lej. (5) PH, VA; 740–810 m; Wpw
Alisma triviale Pursh (17) PH, VA; 635–935 m; Wpw
Sagittaria cuneata E. Sheld. (21) PH, VA; 635–935 m; Wpw
Sagittaria montevidensis Cham. & Schltdl. ssp. *calycina* (Engelm.) Bogin; *K.H. Lackschewitz 8613* (MONT); PH

Alliaceae

Allium cernuum Roth (9) PH; 895–1735 m; Fmc, Fmr, Fpj, Fpp, Gmm
Allium textile A. Nelson & J.F Macbr. (86) PH, VA; 620–1440 m; Fpj, Gmg, Gup, Sgs, Sss

Amaranthaceae

Amaranthus albus L. (4) PH, VA; 650–895 m; D, Frc
Amaranthus arenicola I.M. Johnst.; *K.H. Lackschewitz 8372* (MONT, MONTU), *K.H. Lackschewitz 8595* (MONT, MONTU); PH
Amaranthus blitoides S. Watson (4) PH, VA; 680–825 m; D
Amaranthus californicus (Moq.) S. Watson; *W.E. Booth 61722* (MONT); VA
**Amaranthus retroflexus* L. (4) PH, VA; 650–780 m; D, Frc
Atriplex argentea Nutt. var. *argentea* (22) PH, VA; 675–905 m; D, Gmg, Sss, Vbl
Atriplex confertifolia (Torr. & Frém.) S. Watson (5) PH, VA; 685–945 m; Gup, Sss, Vbl
Atriplex dioica Raf. (3) PH, VA; 650–670 m; Wpw
Atriplex gardneri (Moq.) D. Dietr. var. *aptera* (A. Nelson) S.L. Welsh & Crompton; *K.H. Lackschewitz 8597* (MONTU); PH
Atriplex gardneri (Moq.) D. Dietr. var. *gardneri* (72) PH, VA; 650–970 m; Gmg, Sgs, Sss, Vbl
**Atriplex heterosperma* Bunge (5) PH; 660–690 m; Frc, Gmg
**Atriplex hortensis* L.; *R. Feigel s.n.* (MONT); PH
Atriplex patula L. (2) VA; 740–845 m; Wpw
Atriplex powellii S. Watson; *E.J. Bell s.n.* (MONT), *K.H. Lackschewitz 8633* (MONT, MONTU), *P. Lesica 4597* (MONTU); PH, VA
Atriplex suckleyi (Torr.) Rydb. (66) PH, VA; 660–1005 m; D, Gmg, Sgs, Sss, Vbl
**Bassia hyssopifolia* (Pall.) Kuntze (1) VA; 790–810 m; Sss
Chenopodium berlandieri Moq. var. *zschackei* (Murr) Murr ex Asch. (29) PH, VA; 650–1340 m; D, Fpj, Frc, Ftw, Gup, Sgs, Wcb
Chenopodium desiccatum A. Nelson (6) PH, VA; 715–895 m; D, Gmg
Chenopodium fremontii S. Watson (6) PH, VA; 675–935 m; Fpj, Frc, Ftw, Sjw
Chenopodium glaucum L. var. *salinum* (Standl.) B. Boivin (7) PH, VA; 650–865 m; Frc, Wcb, Wpw
Chenopodium pratericola Rydb. (21) PH, VA; 635–975 m; D, Gmg, Gup, Sss, Wpw
Chenopodium rubrum L. var. *rubrum* (1) PH; 660 m; Frc
**Halogeton glomeratus* (M. Bieb.) C.A. Mey. (1) PH; 855–900 m; Wcb
**Kochia scoparia* (L.) Schrad. (25) PH, VA; 650–905 m; D, Frc, Wcb
Krascheninnikovia lanata (Pursh) A. Meeuse & A. Smit (39) PH, VA; 670–990 m; Gmg, Gup, Sss
Monolepis nuttalliana (Schult.) Greene (80) PH, VA; 620–990 m; D, Gmg, Sgs, Sss, Vbl, Wcb
Salicornia rubra A. Nelson (4) PH; 675–935 m; Sgs, Wal
**Salsola tragus* L. (14) PH, VA; 650–855 m; D, Gmg
Suaeda calceoliformis (Hook.) Moq. (19) PH, VA; 650–935 m; D, Sgs, Sss, Vbl, Wal
Suaeda nigra (Raf.) J.F. Macbr. (6) PH, VA; 710–915 m; Sgs, Sss, Vbl
♦ *Suckleya suckleyana* (Torr.) Rydb. (5) VA; 670–800 m; D, Wpw

Anacardiaceae

Rhus trilobata Nutt. var. *trilobata* (93) PH, VA; 620–1440 m; Fpj, Ftw, Gmg, Gup, Sjw, Wcb
Toxicodendron rydbergii (Small ex Rydb.) Greene (12) PH, VA; 690–1320 m; Ftw, Wcb

Apiaceae

Cicuta maculata L. var. *angustifolia* Hook. (4) PH, VA; 800–930 m; Wpw
Cymopterus acaulis (Pursh) Raf. (14) PH, VA; 655–915 m; Gmg, Gup, Sss
Heracleum maximum Bartr. (7) PH, VA; 950–1470 m; Fmr

Lomatium cous (S. Watson) J.M. Coult. & Rose (6) PH, VA; 855–1645 m; Fmc, Fmr, Fpp, Gmg, Gmm, Wcb
Lomatium foeniculaceum (Nutt.) J.M. Coult. & Rose var. *foeniculaceum* (58) PH, VA; 620–990 m; Gmg, Gup, Sgs, Sss
Lomatium macrocarpum (Nutt. ex Torr. & A. Gray) J.M. Coult. & Rose (21) PH, VA; 670–1735 m; Fpp, Gmg, Sss
Musineon divaricatum (Pursh) Nutt. ex Torr. & A. Gray (62) PH, VA; 620–1005 m; Fpj, Gmg, Sgs, Sss
Osmorhiza chilensis Hook. & Arn. (6) PH; 1220–1735 m; Fmc, Fmr
Osmorhiza depauperata Phil. (6) PH; 1255–1735 m; Fmc, Fmr
Osmorhiza longistylis (Torr.) DC.; *P. Lesica 8074* (MONTU); PH
Perideridia montana (Blank.) Dorn (1) PH; 1320–1450 m; Fmc
Sanicula marilandica L. (9) PH; 1195–1685 m; Fmc, Fmr
Sium suave Walter (2) VA; 830–895 m; Wpw
Zizia aptera (A. Gray) Fernald (1) VA; 925–960 m; Wcb

Apocynaceae

Apocynum androsaemifolium L. (9) PH; 1220–1675 m; D, Fmc, Fmr, Fpp, Gmm
Apocynum cannabinum L. (5) PH, VA; 670–835 m; Gmg, Sgs, Wcb, Wpw
Asclepias pumila (A. Gray) Vail (2) VA; 785–890 m; Fpj, Sss
Asclepias speciosa Torr. (14) PH, VA; 675–1145 m; D, Wcb, Wpw
Asclepias verticillata L. (1) PH; 915–970 m; Gmg
Asclepias viridiflora Raf. (5) PH, VA; 745–945 m; Fpj, Ftw, Gmg, Gup, Sss

Araceae

Lemna turionifera Landolt (3) PH, VA; 675–835 m; Wpw

Asparagaceae

**Asparagus officinalis* L. (1) PH; 670 m; Wpw
Maianthemum racemosum (L.) Link var. *amplexicaule* (Nutt.) Dorn (19) PH; 1195–1735 m; Fmc, Fmr
Maianthemum stellatum (L.) Link (21) PH, VA; 685–1685 m; Fmc, Fmr, Fpp, Ftw, Wcb
Yucca glauca Nutt. (12) PH, VA; 675–1145 m; Gup

Asteraceae

Achillea millefolium L. (154) PH, VA; 620–1740 m; D, Fmc, Fmr, Fpj, Gmg, Sjw, Sss, Wcb
*● *Acroptilon repens* (L.) DC. (1) PH; 690 m; Frc
Agoseris glauca (Pursh) Raf. var. *dasycephala* (Torr. & A. Gray) Jeps. (13) PH, VA; 730–990 m; Gmm, Sss, Wcb
Agoseris glauca (Pursh) Raf. var. *glauca* (18) PH, VA; 745–1575 m; Ftw, Gmg, Gmm, Sss, Wcb
Agoseris parviflora (Nutt.) D. Dietrich (4) PH, VA; 620–885 m; Fpj, Gmg, Gup, Sss
Almutaster pauciflorus (Nutt.) Á. Löve & D. Löve (1) VA; 845 m; Wpw
Ambrosia artemisiifolia L. (7) PH, VA; 650–845 m; D, Ftw, Wcb, Wpw
Ambrosia tomentosa Nutt.; *L.E. Thayer s.n.* (MONT); PH
Ambrosia trifida L. (5) PH, VA; 675–835 m; Frc, Sgs, Wpw
Anaphalis margaritacea (L.) Benth. & Hook. (3) PH; 1270–1395 m; Fmr
Antennaria dimorpha (Nutt.) Torr. & A. Gray; *A. Taylor 8561* (MONT); PH
Antennaria howellii Greene ssp. *howellii* (3) PH; 1295–1440 m; Flp, Fmc, Gmm
Antennaria howellii Greene ssp. *petaloidea* (Fernald) R.J. Bayer (15) PH, VA; 620–1735 m; Flp, Fmc, Fmr, Fpj, Fpp, Ftw, Gmg, Gmm, Sss
Antennaria microphylla Rydb. (33) PH, VA; 675–1145 m; Gmg, Sss, Wcb
Antennaria parvifolia Nutt. (97) PH, VA; 620–1675 m; Fpj, Gmg, Gmm, Gup, Sss, Wcb
Antennaria racemosa Hook. (3) PH; 1355–1735 m; Flp, Fmc, Fmr
Antennaria rosea Greene (31) PH, VA; 620–1495 m; Fpj, Ftw, Gmg, Wcb
**Arctium minus* Bernh. (2) PH; 1220–1245 m; D, Fmr
Arnica cordifolia Hook. (6) PH; 1195–1575 m; Flp, Fmc, Fmr, Fpp
Arnica fulgens Pursh (29) PH, VA; 660–990 m; Gmg, Wcb
Arnica sororia Greene (30) PH, VA; 620–1145 m; Gmg, Sss, Wcb
**Artemisia absinthium* L.; *D. Reinhard s.n.* (MONT); VA
Artemisia biennis Willd. var. *biennis* (6) PH, VA; 650–870 m; Wcb, Wpw
Artemisia campestris L. var. *caudata* (Michx.) Palmer & Steyerm. (1) VA; 830–890 m; Fpj
Artemisia campestris L. var. *pacifica* (Nutt.) M. Peck (32) PH, VA; 650–1740 m; Fpp, Gmg, Gup, Sss
Artemisia cana Pursh var. *cana* (38) PH, VA; 650–930 m; Gmg, Sss, Wcb
Artemisia dracunculus L. (15) PH, VA; 650–1225 m; D, Frc, Ftw, Gmg
Artemisia frigida Willd. (66) PH, VA; 650–1225 m; Gmg, Gup, Sss, Wcb
Artemisia longifolia Nutt. (17) PH, VA; 675–975 m; Fpj, Gmg, Sgs, Sss
Artemisia ludoviciana Nutt. var. *ludoviciana* (68) PH, VA; 650–1490 m; Frc, Ftw, Gmg, Gmm, Sss, Wcb, Wpw
Artemisia tridentata Nutt. var. *wyomingensis* (Beetle & Young) S.L. Welsh (14) PH, VA; 670–905 m; Fpj, Sgs, Sjw, Sss
Balsamorhiza sagittata (Pursh) Nutt. (7) PH; 1195–1685 m; Fmc, Fpp, Gmm
Bidens cernua L. (2) PH, VA; 650–690 m; Wpw
Bidens tripartita L. (2) PH; 660–690 m; Wpw
Brickellia eupatorioides (L.) Shinners var. *corymbulosa* (Torr. & A. Gray) Shinners (1) PH; 670 m; Gup
**Carduus acanthoides* L. (1) PH; 685–690 m; Wpw
*● *Centaurea diffusa* Lam. (1) VA; 685–730 m; Wcb
*● *Centaurea stoebe* L. ssp. *micranthos* (S.G. Gmel. ex Gugler) Hayek (7) PH, VA; 830–1615 m; D, Gmm, Wcb
Chaenactis douglasii (Hook.) Hook. & Arn. var. *douglasii* (18) PH, VA; 665–935 m; Fpj, Gmg, Gup, Sss, Vbl
*● *Cirsium arvense* (L.) Scop. (34) PH, VA; 675–1740 m; D, Fmr, Ftw, Wcb, Wpw
Cirsium canescens Nutt. (5) PH, VA; 760–1050 m; Fpj, Gmg, Wcb
Cirsium flodmanii (Rydb.) Arthur (15) PH, VA; 740–1450 m; Fpp, Wcb, Wpw
Cirsium hookerianum Nutt. (1) PH; 940–975 m; Gup
Cirsium undulatum (Nutt.) Spreng. (28) PH, VA; 670–1490 m; D, Fpj, Fpp, Gmg, Sss, Wcb
**Cirsium vulgare* (Savi) Ten. (9) PH, VA; 685–1340 m; Fmr, Wcb
Conyza canadensis (L.) Cronquist (44) PH, VA; 650–975 m; D, Gmg, Sss, Wcb, Wpw
Coreopsis tinctoria Nutt. (9) PH, VA; 650–855 m; D, Wpw
Crepis atribarba A. Heller (3) PH, VA; 690–1395 m; Fpp, Gup
Crepis modocensis Greene var. *modocensis* (8) PH, VA; 710–885 m; Gmg, Gup, Sss
Crepis occidentalis Nutt. var. *costata* A. Gray (25) PH, VA; 620–1145 m; Fpj, Gmg, Sss
Crepis runcinata (E. James) Torr. & A. Gray var. *runcinata* (2) PH, VA; 850–960 m; Wal, Wcb
**Crepis tectorum* L. (10) VA; 660–990 m; D, Gmg, Sss, Wcb
Cyclachaena xanthifolia (Nutt.) Fresen. (6) PH, VA; 650–1225 m; D, Frc
Dieteria canescens (Pursh) Nutt. var. *canescens* (52) PH, VA; 640–990 m; D, Gmg, Sgs, Sss
Dyssodia papposa (Vent.) Hitchc. (1) PH; 770–780 m; Sjw
Echinacea angustifolia DC. (2) PH, VA; 685–945 m; Ftw, Gup
Ericameria nauseosa (Pall. ex Pursh) G.L. Nesom & G.I. Baird var. *graveolens* (Nutt.) Reveal & Schuyler (7) PH, VA; 685–1485 m; Frc, Gup, Sjw, Wcb
Ericameria nauseosa (Pall. ex Pursh) G.L. Nesom & G.I. Baird var. *nauseosa* (18) PH, VA; 670–895 m; Gmg, Gup, Sgs, Sss
Erigeron caespitosus Nutt. (30) PH, VA; 680–1735 m; Fpj, Fpp, Gmg, Gmm, Gup, Sss, Vot
Erigeron compositus Pursh (13) PH, VA; 670–1440 m; Gmg, Gup, Vot

Erigeron corymbosus Nutt. (2) PH, VA; 830–1450 m; Fpp, Wcb
Erigeron glabellus Nutt. var. *glabellus* (13) PH, VA; 690–990 m; Ftw, Wcb
Erigeron glabellus Nutt. var. *pubescens* Hook. (2) PH, VA; 730–845 m; Gmg, Wcb
Erigeron ochroleucus Nutt.; *A. Taylor 8590* (MONT); PH
Erigeron pumilus Nutt. var. *pumilus* (91) PH, VA; 620–1145 m; Fpj, Gmg, Gmm, Sss
Erigeron speciosus (Lindl.) DC. (3) PH; 1195–1470 m; Fmr, Fpp
Erigeron strigosus Muhl. ex Willd. var. *septentrionalis* (Fernald & Wiegand) Fernald (1) PH; 1480–1685 m; Fmc
Erigeron strigosus Muhl. ex Willd. var. *strigosus* (1) PH; 885–945 m; Gmg
Eurybia conspicua (Lindl.) G.L. Nesom (3) PH; 1195–1485 m; Fmc, Fmr
Gaillardia aristata Pursh (51) PH, VA; 675–1735 m; Fmc, Fpp, Gmg, Gup, Sss, Wcb
Gnaphalium palustre Nutt. (7) PH, VA; 690–915 m; Frc, Wcb
Grindelia squarrosa (Pursh) Dunal (82) PH, VA; 650–1485 m; D, Gmg, Sgs, Sss, Wcb
Gutierrezia sarothrae (Pursh) Britton & Rusby (53) PH, VA; 650–1365 m; Gmg, Sgs, Sss
Helenium autumnale L. (1) PH; 690 m; Wpw
Helianthus annuus L. (64) PH, VA; 635–1225 m; D, Gmg, Sgs, Sss
Helianthus maximiliani Schrad. (14) PH, VA; 685–945 m; Ftw, Wcb, Wpw
Helianthus nuttallii Torr. & A. Gray ssp. *nuttallii* (8) PH, VA; 650–890 m; Wcb, Wpw
Helianthus nuttallii Torr. & A. Gray ssp. *rydbergii* (Britton) R.W. Long (1) VA; 690 m; Wpw
Helianthus pauciflorus Nutt. var. *subrhomboideus* (Rydb.) Cronquist (7) PH; 1195–1490 m; Fmc, Fpp
Helianthus petiolaris Nutt. var. *petiolaris* (24) PH, VA; 660–955 m; D, Gmg, Gup, Sss
Heterotheca horrida (Rydb.) V.L. Harms; *J. Mundinger 172* (MONT); PH
Heterotheca villosa (Pursh) Shinners var. *villosa* (98) PH, VA; 635–1675 m; Gmg, Gup, Sss
Hieracium albiflorum Hook. (1) PH; 1275–1350 m; Flp
Hieracium scouleri Hook. (1) PH; 1360–1450 m; Fpp
Hieracium umbellatum L. (10) PH; 1195–1490 m; Flp, Fmc, Fmr, Fpp
Hymenopappus filifolius Hook. var. *polycephalus* (Osterh.) B.L. Turner (41) PH, VA; 675–1450 m; Gmg, Gup, Sss
Hymenoxys richardsonii (Hook.) Cockerell var. *richardsonii* (75) PH, VA; 620–1050 m; Fpj, Gmg, Gup, Sss
Iva axillaris Pursh (75) PH, VA; 620–1050 m; D, Fpj, Gmg, Sgs, Sss, Vbl, Wal
Lactuca ludoviciana (Nutt.) Riddell (3) PH; 1270–1395 m; Fmr
**Lactuca serriola* L. (44) PH, VA; 650–1490 m; D, Gmg, Sgs, Sss, Wcb, Wpw
*● *Leucanthemum vulgare* Lam. (1) PH; 1270–1395 m; Fmr
Liatris punctata Hook. var. *punctata* (30) PH, VA; 670–1485 m; Fpp, Gmg, Gmm, Sss, Wcb
**Logfia arvensis* (L.) Holub (53) PH, VA; 640–1735 m; Fpj, Gmg, Sss, Wcb
Lygodesmia juncea (Pursh) D. Don ex Hook. (10) PH, VA; 685–945 m; D, Gmg, Sss
Madia glomerata Hook. (4) PH, VA; 775–915 m; D, Ftw, Wcb, Wpw
**Matricaria discoidea* DC.; *M.G. Atwater s.n.* (MONT); PH
Microseris nutans (Hook.) Sch. Bip. (7) PH; 745–980 m; Fpj, Gmg, Sss
Mulgedium pulchellum (Pursh) G. Don (28) PH, VA; 675–945 m; D, Ftw, Gmg, Sjw, Wcb, Wpw
Nothocalais cuspidata (Pursh) Greene (26) PH, VA; 685–1005 m; Gmg, Sss, Wcb
Packera cana (Hook.) W.A. Weber & Á. Löve (74) PH, VA; 620–1735 m; Fpj, Gmg, Gup, Sjw, Sss
Packera paupercula (Michx.) Á. Löve & D. Löve (2) PH; 1270–1395 m; Fmr
Picradeniopsis oppositifolia (Nutt.) Rydb. ex Britton (9) PH, VA; 715–1050 m; D, Sss
♦ *Psilocarphus brevissimus* Nutt. var. *brevissimus* (1) PH; 790 m; Wpw
Pyrrocoma lanceolata (Hook.) Greene var. *lanceolata* (2) VA; 830–845 m; Wpw
Ratibida columnifera (Nutt.) Wooton & Standl. (89) PH, VA; 635–1230 m; Fpj, Gmg, Sss, Wcb
**Scorzonera laciniata* L.; *P. Lesica 8114* (MONTU); PH
♦ *Senecio eremophilus* Richardson var. *eremophilus* (3) PH; 1290–1740 m; D, Fmc
Senecio integerrimus Nutt. var. *exaltatus* (Nutt.) Cronquist (4) PH, VA; 790–865 m; Gmg, Wcb
Senecio integerrimus Nutt. var. *integerrimus* (17) PH, VA; 690–990 m; Gmg, Gup
Senecio integerrimus Nutt. var. *scribneri* (Rydb.) T.M. Barkley (19) PH, VA; 670–990 m; Gmg, Sgs, Sss
Solidago altissima L. var. *gilvocanescens* (Rydb.) Semple (5) PH, VA; 730–870 m; Wcb, Wpw
Solidago gigantea Aiton (19) PH, VA; 650–1490 m; Fmr, Frc, Ftw, Wcb, Wpw
Solidago lepida DC. var. *lepida* (4) PH, VA; 770–1340 m; Fmr, Gmg, Wcb
Solidago lepida DC. var. *salebrosa* (Piper) Semple (4) PH; 1240–1485 m; Flp, Fmr, Gmm
Solidago missouriensis Nutt. (58) PH, VA; 670–1575 m; D, Ftw, Gmg, Sss, Wcb
Solidago mollis Bartl. (13) PH, VA; 670–1365 m; Gmm, Gup, Wcb
Solidago nemoralis Aiton var. *longipetiolata* (Mack. & Bush) E.J. Palmer & Steyerm. (13) PH, VA; 755–1645 m; Flp, Fmc, Fpj, Fpp, Ftw, Gmm, Sss
Solidago rigida L. var. *humilis* Porter (19) PH, VA; 690–1450 m; Fpp, Ftw, Gmm, Wcb, Wpw
Solidago simplex Kunth var. *simplex* (5) PH; 1250–1740 m; D, Fpp
**Sonchus arvensis* L. ssp. *uliginosus* (M. Bieb.) Nyman (24) PH, VA; 660–1490 m; Frc, Wcb, Wpw
Stenotus acaulis (Nutt.) Nutt.; *F.B. Cotner s.n.* (MONTU); PH
Stenotus armerioides Nutt. var. *armerioides* (15) PH, VA; 700–1145 m; Fpj, Gmg, Gup
Stephanomeria runcinata Nutt. (19) PH, VA; 675–1450 m; Gmg, Gup, Sgs
Stephanomeria tenuifolia (Raf.) H.M. Hall (8) PH, VA; 680–1050 m; Fpj, Gmg
Symphyotrichum ascendens (Lindl.) G.L. Nesom (11) PH, VA; 680–930 m; Wcb, Wpw
Symphyotrichum ciliatum (Ledeb.) G.L. Nesom (3) PH, VA; 650–865 m; Wpw
Symphyotrichum ciliolatum (Lindl.) Á. Löve (9) PH; 1195–1490 m; Fmr, Gmm
Symphyotrichum eatonii (A. Gray) G.L. Nesom (3) PH; 1195–1340 m; Fmr
Symphyotrichum ericoides (L.) G.L. Nesom var. *pansum* (S.F. Blake) G.L. Nesom (10) PH, VA; 650–930 m; Wcb, Wpw
Symphyotrichum falcatum (Lindl.) G.L. Nesom var. *commutatum* (Torr. & A. Gray) G.L. Nesom (15) PH, VA; 650–1365 m; Gmg, Gmm, Sss, Wpw
Symphyotrichum falcatum (Lindl.) G.L. Nesom var. *falcatum* (24) PH, VA; 660–1485 m; D, Ftw, Gmg, Sss, Wcb, Wpw
Symphyotrichum laeve (L.) Á. Löve & D. Löve var. *geyeri* (A. Gray) G.L. Nesom (6) PH, VA; 650–1365 m; Fmr, Fpp, Frc, Ftw
Symphyotrichum lanceolatum (Willd.) G.L. Nesom var. *hesperium* (A. Gray) G.L. Nesom (7) PH, VA; 650–915 m; Frc, Wcb, Wpw
*● *Tanacetum vulgare* L.; *B. Crater s.n.* (MONT); VA

Taraxacum erythrospermum Andrz. ex Besser (50) PH, VA; 655–1440 m; D, Gmg, Sss
**Taraxacum officinale* Weber ex F.H. Wigg. (7) PH, VA; 670–1440 m; D, Gmg, Sss
Tetraneuris acaulis (Pursh) Greene var. *acaulis* (19) PH; 690–1450 m; Fmc, Fpj, Fpp, Gmg, Gup, Sss
Townsendia exscapa (Richardson) Porter (1) VA; 655–660 m; Gmg
Townsendia hookeri Beaman (5) PH, VA; 670–1440 m; Gmg, Gup, Vot
**Tragopogon dubius* Scop. (128) PH, VA; 620–1735 m; D, Fpj, Gmg, Gup, Sgs, Sjw, Sss, Wcb
Xanthisma grindelioides (Nutt.) D.R. Morgan & R.L. Hartm. var. *grindelioides* (25) PH, VA; 675–1145 m; Gmg, Gup, Sss
Xanthisma spinulosum (Pursh) D.R. Morgan & R.L. Hartm. var. *spinulosum* (19) PH, VA; 670–935 m; Gmg, Gup, Sss
Xanthium strumarium L. (51) PH, VA; 650–935 m; D, Frc, Wal, Wcb, Wpw

Berberidaceae

Berberis repens Lindl. (8) PH; 1195–1485 m; Flp, Fmc, Fmr, Fpp

Betulaceae

Betula occidentalis Hook. (1) VA; 680–750 m; Ftw
Betula papyrifera Marshall var. *papyrifera* (19) PH; 1195–1685 m; Fmc, Fmr

Boraginaceae

**Asperugo procumbens* L.; *D. Young s.n.* (MONT); PH
Cryptantha celosioides (Eastw.) Payson (14) PH, VA; 640–1050 m; Gup
Cryptantha minima Rydb. (3) VA; 640–675 m; Gmg
Cryptantha spiculifera (Piper) Payson (20) PH, VA; 675–1145 m; Gmg, Gup
Cryptantha torreyana (A. Gray) Greene (2) PH; 805–935 m; Fpj
*● *Cynoglossum officinale* L. (6) PH; 760–1440 m; D, Gmm
Ellisia nyctelea (L.) L. (10) PH, VA; 685–885 m; D, Fpj, Sjw, Vbl
Hackelia deflexa (Wahlenb.) Opiz var. *americana* (A. Gray) Fernald & I.M. Johnst. (2) PH; 845–900 m; Ftw
Hackelia floribunda (Lehm.) I.M. Johnst. (4) PH, VA; 870–1340 m; Fmr, Ftw, Wcb
Heliotropium curassavicum L. var. *obovatum* DC. (2) PH; 675–730 m; Wal
Lappula cenchrusoides A. Nelson (23) PH, VA; 640–975 m; D, Gmg, Gup, Sgs, Sss
Lappula occidentalis (S. Watson) Greene var. *occidentalis* (52) PH, VA; 660–1225 m; D, Gmg, Gup, Sss, Wcb
**Lappula squarrosa* (Retz.) Dumort. (5) PH, VA; 830–1225 m; D, Gmg, Sss
Lithospermum incisum Lehm. (30) PH, VA; 670–1370 m; Gmg, Gup, Sjw, Sss
Lithospermum ruderale Douglas ex Lehm. (5) PH; 1195–1440 m; Fpp, Gmm
Mertensia lanceolata (Pursh) DC. (11) PH, VA; 670–925 m; Gmg, Wcb
Phacelia linearis (Pursh) Holz. (30) PH, VA; 620–1675 m; Fpj, Gmg, Sss
♦*Phacelia thermalis* Greene; *R. Feigel s.n.* (MONT), *K.H. Lackschewitz 8125* (MONT, MONTU); PH
♦ *Plagiobothrys leptocladus* (Greene) I.M. Johnst. (9) PH, VA; 745–885 m; Wcb, Wpw
Plagiobothrys scouleri (Hook. & Arn.) I.M. Johnst. var. *hispidulus* (Greene) Dorn (7) PH, VA; 740–930 m; Wcb, Wpw

Brassicaceae

**Alyssum alyssoides* (L.) L. (8) PH; 755–1575 m; D, Sss
**Alyssum desertorum* Stapf (49) PH, VA; 655–1005 m; D, Gmg, Sss
Arabis eschscholtziana Andrz. (1) PH; 1275 m; D
Arabis pycnocarpa M. Hopkins var. *pycnocarpa* (21) PH, VA; 620–1735 m; Gmm, Wcb
**Armoracia rusticana* P. Gaertn., B. Mey., & Schreb.; *K.H. Lackschewitz 8043* (MONT, MONTU), *R. Stellflug s.n.* (MONT); VA
Boechera collinsii (Fernald) Löve & D. Löve (63) PH, VA; 620–1735 m; Gmg, Sss
Boechera grahamii (Lehm.) Windham & Al-Shehbaz (20) PH, VA; 690–1365 m; Gmg
Boechera holboellii (Hornem.) Á. Löve & D. Löve var. *secunda* (Howell) Dorn (3) PH, VA; 700–1160 m; D, Sss
**Camelina microcarpa* Andrz. ex DC. (73) PH, VA; 635–1575 m; D, Ftw, Gmg, Sss, Wcb
**Capsella bursa-pastoris* (L.) Medik. (5) PH, VA; 725–1340 m; D
**Chorispora tenella* (Pall.) DC. (2) PH, VA; 655–710 m; D
**Conringia orientalis* (L.) Dumort. (23) PH, VA; 635–990 m; Gmg, Sgs, Sss, Vbl
Descurainia incana (Bernh. ex Fisch. & C.A. Mey.) Dorn (1) PH; 845–895 m; Ftw
Descurainia nelsonii (Rydb.) Al-Shehbaz & Goodson (1) PH; 675–685 m; Frc
Descurainia pinnata (Walter) Britton var. *brachycarpa* (Richardson) Fernald (56) PH, VA; 660–1340 m; Fpj, Gmg, Sss
**Descurainia sophia* (L.) Webb ex Prantl (56) PH, VA; 660–990 m; D, Ftw, Gmg
Draba cana Rydb. (3) PH; 1195–1735 m; Vot
**Draba nemorosa* L. var. *nemorosa* (32) PH, VA; 655–1440 m; Gmg, Wcb
Draba reptans (Lam.) Fernald (22) PH, VA; 620–1370 m; Gmg, Gup, Sss
Erysimum asperum (Nutt.) DC. (16) PH, VA; 640–860 m; Gmg, Gup, Sss
Erysimum capitatum (Douglas ex Hook.) Greene var. *purshii* (T. Durand) Rollins (5) VA; 660–955 m; Gmg, Gup, Sss
Erysimum cheiranthoides L. (5) PH, VA; 845–1275 m; D, Ftw
Erysimum inconspicuum (S. Watson) MacMill. (74) PH, VA; 620–1450 m; Fpj, Gmg, Gup, Sss, Wcb
**Hesperis matronalis* L. (2) PH, VA; 660–1470 m; D
**Lepidium campestre* (L.) R. Br. (1) PH; 1220–1340 m; D
Lepidium densiflorum Schrad. var. *densiflorum* (40) PH, VA; 640–1050 m; D, Gmg, Sss
Lepidium densiflorum Schrad. var. *macrocarpum* G.A. Mulligan (48) PH, VA; 620–990 m; D, Gmg, Sgs, Sss
*●*Lepidium latifolium* L.; *D. Ueseth s.n.* (MONT); PH
**Lepidium perfoliatum* L. (13) PH, VA; 640–895 m; D, Gmg, Sgs, Sss
Lepidium ramosissimum A. Nelson var. *bourgeauanum* (Thell.) Rollins (2) VA; 700–905 m; Gmg
Lepidium ramosissimum A. Nelson var. *ramosissimum* (2) VA; 775–835 m; D
**Malcolmia africana* (L.) R. Br. (1) VA; 660 m; D
Physaria arenosa (Richardson) O'Kane & Al-Shehbaz var. *arenosa* (30) PH, VA; 655–1005 m; Gmg, Gup, Sjw, Sss
♦ *Physaria brassicoides* Rydb. (1) PH; 1245–1370 m; Fpp
♦ *Physaria ludoviciana* (Nutt.) O'Kane & Al-Shehbaz (2) PH, VA; 770–830 m; Gmg
Physaria spatulata (Rydb.) Grady & O'Kane (24) PH, VA; 675–1145 m; Fpj, Gmg, Gup, Sss
Rorippa curvipes Greene var. *curvipes* (1) PH; 775–780 m; Wpw
Rorippa sinuata (Nutt.) Hitchc.; *J.W. Blankinship s.n.* (MONT), *T. Fisher s.n.* (MONT), *K.H. Lackschewitz 8843* (MONTU), *P. Lesica 4596* (MONTU); PH, VA
Rorippa tenerrima Greene (1) VA; 830–835 m; Wpw
**Sinapis arvensis* L.; *W.E. Booth s.n.* (MONT); VA
**Sisymbrium altissimum* L. (30) PH, VA; 635–945 m; D, Gmg, Gup, Sss, Wcb
**Sisymbrium loeselii* L.; *F.B. Cotner s.n.* (MONT), *K.H. Lackschewitz 8379* (MONT); PH
**Thlaspi arvense* L. (70) PH, VA; 635–1575 m; D, Ftw, Gmg, Sss, Wcb, Wpw
**Turritis glabra* L. (9) PH, VA; 805–1645 m; D, Fmr, Ftw, Gmm

Cactaceae
Coryphantha missouriensis (Sweet) Britton & Rose var. *missouriensis* (1) PH; 705–730 m; Sss
Coryphantha vivipara (Nutt.) Britton & Rose (7) PH, VA; 790–925 m; Gmg, Sss
Opuntia fragilis (Nutt.) Haw. (7) PH, VA; 620–1145 m; Fpj, Gmg, Sss
Opuntia polyacantha Haw. var. *polyacantha* (63) PH, VA; 635–1145 m; Fpj, Gmg, Sgs, Sss

Campanulaceae
**Campanula rapunculoides* L. (1) PH; 1240–1320 m; Fmr
Campanula rotundifolia L. (44) PH, VA; 675–1740 m; Fmc, Fmr, Ftw, Gmg, Wcb
Triodanis leptocarpa (Nutt.) Nieuwl. (3) PH, VA; 720–830 m; Gmg, Sss

Caprifoliaceae
Linnaea borealis L. var. *longiflora* Torr. (13) PH; 1195–1735 m; Flp, Fmc, Fmr
**Lonicera tatarica* L. (1) VA; 830–835 m; D
Symphoricarpos albus (L.) S.F. Blake var. *albus* (2) PH; 760–1685 m; Fmc, Gmg
Symphoricarpos albus (L.) S.F. Blake var. *laevigatus* (Fernald) S.F. Blake (1) PH; 1275–1350 m; Flp
Symphoricarpos occidentalis Hook. (58) PH, VA; 635–1450 m; Fpj, Frc, Ftw, Wcb, Wpw
Symphoricarpos oreophilus A. Gray var. *utahensis* (Rydb.) A. Nelson (3) PH; 1160–1735 m; Fmc, Gmm

Caryophyllaceae
Cerastium arvense L. var. *strictum* (Gaudin) W.D.J. Koch (60) PH, VA; 685–1735 m; Fpp, Ftw, Gmg, Gmm, Sss, Wcb
Cerastium brachypodum (Engelm. ex A. Gray) B.L. Rob. (3) PH, VA; 830–890 m; Gmg, Wcb, Wpw
**Cerastium fontanum* Baumg. ssp. *vulgare* (Hartm.) Greuter & Burdet (1) PH; 1275–1350 m; Fmr
Eremogone congesta (Nutt.) Ikonn. var. *lithophila* (Rydb.) Dorn (11) PH; 775–1735 m; Gmg, Gmm, Sss, Wcb
Minuartia rubella (Wahlenb.) Hiern (3) PH; 1195–1735 m; Vot
Moehringia lateriflora (L.) Fenzl (8) PH; 1195–1470 m; Fmc, Fmr
Paronychia sessiliflora Nutt. (13) PH, VA; 675–1145 m; Gmg, Gup
**Silene csereii* Baumg. (6) PH, VA; 660–1340 m; D, Fmr
Silene drummondii Hook. var. *drummondii* (2) PH, VA; 775–1350 m; Flp, Gmg
Silene drummondii Hook. var. *striata* (Rydb.) Bocquet (10) PH, VA; 735–1145 m; Fpp, Ftw, Gmg, Sss, Wcb
**Silene latifolia* Poir. (1) PH; 1360–1450 m; Vot
Silene menziesii Hook.; *K.H. Lackschewitz 8122* (MONT); PH
Spergularia marina (L.) Griseb. (3) PH, VA; 650–800 m; Wal, Wpw
Stellaria longifolia Muhl. ex Willd. (1) PH; 1275–1350 m; Fmr
**Stellaria media* (L.) Vill.; *Anonymous s.n.* (MONT); VA
**Vaccaria hispanica* (Mill.) Rauschert; *K.H. Lackschewitz 10023* (MONTU, RM); VA

Ceratophyllaceae
Ceratophyllum demersum L. (5) PH, VA; 775–935 m; Wpw

Cleomaceae
Peritoma serrulata (Pursh) DC. (2) PH; 735–870 m; D, Wcb
Polanisia dodecandra (L.) DC. var. *trachysperma* (Torr. & A. Gray) H.H. Iltis (2) PH, VA; 650–730 m; Gmg, Wpw

Commelinaceae
Tradescantia occidentalis (Britton) Smyth var. *occidentalis* (1) VA; 670–675 m; Gmg

Convolvulaceae
Calystegia macounii (Greene) Brummitt (2) PH; 690–925 m; Wcb, Wpw
**Calystegia sepium* (L.) R. Br. var. *angulata* (Brummitt) N.H. Holmgren (2) PH, VA; 690–790 m; Wpw
*● *Convolvulus arvensis* L. (10) PH, VA; 660–945 m; D, Ftw, Gmg
Cuscuta coryli Engelm.; *J.W. Blankinship s.n.* (MONT); VA
Cuscuta pentagona Engelm. var. *pentagona* (1) VA; 715–745 m; Wpw

Cornaceae
Cornus canadensis L. (5) PH; 1195–1470 m; Flp, Fmr
Cornus sericea L. var. *sericea* (22) PH, VA; 650–1470 m; Fmr, Ftw

Crassulaceae
Sedum lanceolatum Torr. (9) PH; 1270–1735 m; Flp, Fmc, Fmr, Fpp, Gmm, Vot

Cyperaceae
Bolboschoenus fluviatilis (Torr.) Soják (2) VA; 785–895 m; Wpw
Bolboschoenus maritimus (L.) Palla ssp. *paludosus* (A. Nelson) T. Koyama (16) PH, VA; 670–930 m; Wal, Wpw
Carex atherodes Spreng. (1) VA; 800 m; Wpw
Carex aurea Nutt. (2) PH, VA; 925–1285 m; Fmr, Wcb
Carex bebbii (L.H. Bailey) Olney ex Fernald (2) PH, VA; 925–1350 m; Fmr, Wcb
Carex brevior (Dewey) Mack. ex Lunell (29) PH, VA; 670–935 m; Ftw, Wcb, Wpw
Carex deweyana Schwein. var. *deweyana* (2) PH; 1275–1470 m; Fmr
Carex disperma Dewey (1) PH; 1275–1350 m; Fmr
Carex douglasii Boott (1) VA; 670–675 m; Gmg
Carex duriuscula C.A. Mey. (26) PH, VA; 620–1145 m; Fpj, Gmg, Sss
Carex filifolia Nutt. (41) PH, VA; 620–1145 m; Fpj, Gmg, Gup, Sjw, Sss
Carex hoodii Boott (6) PH; 1270–1685 m; Fmc, Fmr, Gmm
Carex inops L.H. Bailey ssp. *heliophila* (Mack.) Crins (20) PH, VA; 620–1365 m; Fpj, Gmg, Sss
Carex laeviconica Dewey (1) PH; 700–705 m; Wpw
Carex lanuginosa Michx. (5) PH, VA; 680–1145 m; Wal, Wcb, Wpw
Carex lasiocarpa Ehrh. (1) PH; 810 m; Wcb
Carex obtusata Lilj. (1) VA; 925–960 m; Gmg
Carex praegracilis W. Boott (24) PH, VA; 675–1145 m; Wcb, Wpw
Carex rossii Boott (3) PH, VA; 800–1735 m; Gmm, Gup
♦ *Carex scoparia* Schkuhr ex Willd. var. *scoparia* (2) PH; 940–1735 m; Ftw, Gmm
Carex sprengelii Dewey ex Spreng. (2) PH, VA; 950–1230 m; Fmr, Ftw
Carex stipata Muhl. ex Willd. var. *stipata* (1) PH; 1195–1230 m; Fmr
Carex vulpinoidea Michx. (2) PH; 770–780 m; Wcb, Wpw
Cyperus squarrosus L. (1) PH; 790–795 m; Wpw
Eleocharis acicularis (L.) Roem. & Schult. (11) PH, VA; 685–915 m; Wal, Wcb, Wpw
Eleocharis palustris (L.) Roem. & Schult. (44) PH, VA; 650–935 m; Wcb, Wpw
Schoenoplectus acutus (Muhl. ex Bigelow) Á. Löve & D. Löve var. *acutus* (9) PH, VA; 670–905 m; Wpw
Schoenoplectus acutus (Muhl. ex Bigelow) Á. Löve & D. Löve var. *occidentalis* (S. Watson) S.G. Sm. (8) PH, VA; 685–935 m; Wal, Wpw
♦ *Schoenoplectus heterochaetus* (Chase) Soják; *P. Lesica 7439* (MONTU); PH
Schoenoplectus pungens (Vahl) Palla var. *pungens* (24) PH, VA; 675–930 m; Wal, Wcb, Wpw
Schoenoplectus tabernaemontani (C.C. Gmel.) Palla (11) PH, VA; 650–880 m; Wcb, Wpw
Scirpus pallidus (Britton) Fernald (1) VA; 830–890 m; Wcb

Elaeagnaceae
**Elaeagnus angustifolia* L. (18) PH, VA; 635–835 m; D, Frc, Ftw, Gmg, Wcb, Wpw
Elaeagnus commutata Bernh. ex Rydb. (4) VA; 700–990 m; Ftw, Gmg, Wcb
Shepherdia argentea (Pursh) Nutt. (35) PH, VA; 635–945 m; Ftw, Wcb, Wpw

Shepherdia canadensis (L.) Nutt. (23) PH, VA; 950–1645 m; Flp, Fmc, Fmr, Fpp, Gmm

Elatinaceae

Elatine rubella Rydb. (3) PH, VA; 745–825 m; Wpw

Ericaceae

Arctostaphylos uva-ursi (L.) Spreng. (24) PH, VA; 885–1735 m; Flp, Fmc, Fmr, Fpp, Gmm

Chimaphila umbellata (L.) W.P.C. Barton var. *occidentalis* (Rydb.) S.F. Blake (2) PH; 1275–1495 m; Flp

Moneses uniflora (L.) A. Gray (2) PH; 1275–1470 m; Flp, Fmr

Orthilia secunda (L.) House (10) PH; 1240–1735 m; Flp, Fmc, Fmr, Gmm

Pterospora andromedea Nutt. (15) PH; 1195–1735 m; Flp, Fmc, Fmr, Fpp

Pyrola asarifolia Michx. var. *asarifolia* (7) PH; 1220–1470 m; Fmc, Fmr

Pyrola chlorantha Sw. (4) PH; 1270–1735 m; Flp, Fmr

Euphorbiaceae

Chamaesyce glyptosperma (Engelm.) Small (24) PH, VA; 650–930 m; D, Frc

Chamaesyce serpens (Kunth) Small (5) PH, VA; 650–825 m; D

Chamaesyce serpyllifolia (Pers.) Small (16) PH, VA; 670–885 m; D, Sss, Vbl

*● *Euphorbia esula* L. var. *esula* (7) PH, VA; 650–815 m; Frc, Sjw, Sss, Wcb, Wpw

*● *Euphorbia esula* L. var. *uralensis* (Fisch. ex Link) Dorn (13) PH, VA; 620–915 m; D, Frc, Ftw, Gmg, Wcb, Wpw

Euphorbia spathulata Lam. (15) PH, VA; 690–1145 m; Fpj, Gmg, Sgs, Wcb

Fabaceae

Astragalus adsurgens Pall. var. *robustior* Hook. (53) PH, VA; 675–1575 m; Fpj, Ftw, Gmg, Gup, Sjw, Sss

Astragalus agrestis Douglas ex G. Don (64) PH, VA; 665–1365 m; Fpj, Ftw, Gmg, Sss, Wcb

Astragalus americanus (Hook.) M.E. Jones (3) PH; 1270–1470 m; Fmr

Astragalus bisulcatus (Hook.) A. Gray var. *bisulcatus* (47) PH, VA; 680–1050 m; D, Fpj, Gmg, Gup, Sgs, Sss, Vbl, Wcb

Astragalus canadensis L. var. *canadensis* (2) PH; 1320–1450 m; Fmc, Fpp

Astragalus cibarius E. Sheld. (2) PH, VA; 715–1160 m; Sss

**Astragalus cicer* L. (4) PH; 1260–1740 m; D, Flp, Fmc, Fmr

Astragalus crassicarpus Nutt. var. *crassicarpus* (4) PH, VA; 705–880 m; Gmg, Gup

Astragalus crassicarpus Nutt. var. *paysonii* (E.H. Kelso) Barneby (16) PH, VA; 695–1440 m; Gmg, Gmm, Gup, Sss

Astragalus drummondii Douglas ex Hook. (39) PH, VA; 675–1440 m; Gmg, Gmm, Gup, Sss

Astragalus flexuosus (Hook.) Douglas ex G. Don var. *flexuosus* (5) VA; 775–990 m; Gmg, Gup

Astragalus gilviflorus E. Sheld. var. *gilviflorus* (38) PH, VA; 655–1450 m; Fpj, Gmg, Gup, Sss

Astragalus gracilis Nutt.; *K.H. Lackschewitz 8375* (MONT, MONTU); PH

Astragalus kentrophyta A. Gray var. *kentrophyta* (1) VA; 800–840 m; Gup

Astragalus lotiflorus Hook. (7) PH, VA; 760–1050 m; Fpj, Gmg, Sss

Astragalus missouriensis Nutt. var. *missouriensis* (74) PH, VA; 655–1370 m; Gmg, Gup, Sgs, Sss

Astragalus pectinatus (Hook.) Douglas ex G. Don (38) PH, VA; 705–960 m; Gmg, Gup, Wcb

Astragalus purshii Douglas ex Hook. var. *purshii* (11) PH, VA; 695–860 m; Gmg, Sss

Astragalus spatulatus E. Sheld. (9) PH, VA; 760–925 m; Gmg, Gup

Astragalus tenellus Pursh (9) PH, VA; 745–990 m; Ftw, Gmg, Gup

**Caragana arborescens* Lam. (3) PH, VA; 685–835 m; D

Dalea candida Michx. var. *oligophylla* (Torr.) Shinners (35) PH, VA; 670–1050 m; Fpj, Gmg, Gup, Sss

Dalea purpurea Vent. var. *purpurea* (63) PH, VA; 635–1485 m; Fpj, Fpp, Gmg, Gup, Sjw, Sss

Glycyrrhiza lepidota Pursh (66) PH, VA; 635–1370 m; Fmr, Frc, Ftw, Gmg, Gup, Wcb, Wpw

Hedysarum alpinum L. var. *philoscia* (A. Nelson) Rollins (2) PH; 1275–1495 m; Flp, Gmm

Hedysarum boreale Nutt. var. *boreale* (4) PH, VA; 700–1145 m; Ftw, Gmg, Gup

Hedysarum boreale Nutt. var. *pabulare* (A. Nelson) Dorn (6) PH, VA; 730–1050 m; Fpj, Ftw, Gup

Hedysarum sulphurescens Rydb. (6) PH; 1275–1735 m; Flp, Fmc, Fmr

Lathyrus ochroleucus Hook. (4) PH; 1275–1470 m; Fmc, Fmr

**Lotus corniculatus* L. (3) PH; 1260–1740 m; D, Fmr

Lotus unifoliolatus (Hook.) Benth. var. *unifoliolatus* (3) VA; 650–835 m; Gmg, Wcb

Lupinus polyphyllus Lindl. var. *humicola* (A. Nelson) Barneby; *W.E. Booth 59559* (MONT, RM), *W.E. Booth 59560* (MONT); VA

Lupinus pusillus Pursh var. *pusillus* (16) PH, VA; 670–945 m; Gmg, Gup

**Medicago lupulina* L. (46) PH, VA; 620–1685 m; D, Fmc, Fmr, Fpj, Wcb

**Medicago sativa* L. (52) PH, VA; 635–1365 m; D, Fpj, Ftw, Gmg, Sgs, Sss, Wcb

**Melilotus albus* Medik. (7) PH, VA; 660–1340 m; D, Fmr, Gmg

**Melilotus officinalis* (L.) Pall. (110) PH, VA; 620–1350 m; D, Fpj, Gmg, Gup, Sgs, Sjw, Sss

Oxytropis besseyi (Rydb.) Blank. var. *argophylla* (Rydb.) Barneby (1) VA; 925–960 m; Gmg

Oxytropis besseyi (Rydb.) Blank. var. *besseyi* (3) PH, VA; 745–955 m; Gup

Oxytropis campestris (L.) DC. var. *spicata* Hook. (25) PH, VA; 745–990 m; Gmg

Oxytropis lambertii Pursh var. *lambertii* (30) PH, VA; 640–1145 m; Gmg, Gup, Sss

×*Oxytropis lambertii* Pursh × *Oxytropis sericea* Nutt. (3) PH, VA; 730–825 m; Gmg, Sss

Oxytropis sericea Nutt. var. *sericea* **(3)** PH; 760–975 m; Fpj, Gup

Oxytropis sericea Nutt. var. *speciosa* (Torr. & A. Gray) S.L. Welsh **(30)** PH, VA; 690–1440 m; Gmg, Gup, Sss

Oxytropis splendens Douglas ex Hook. **(8)** PH; 1220–1575 m; Flp, Fmc, Fmr, Fpp, Gmm

Pediomelum argophyllum (Pursh) J.W. Grimes **(93)** PH, VA; 635–1365 m; Fpj, Gmg, Gup, Sss, Wcb

Pediomelum esculentum (Pursh) Rydb. **(42)** PH, VA; 640–1450 m; Fpj, Gmg, Gup, Sss

Psoralidium lanceolatum (Pursh) Rydb. **(5)** VA; 730–880 m; Fpj, Ftw, Gup

Psoralidium tenuiflorum (Pursh) Rydb.; *J.W. Blankinship s.n.* (MONT); PH

Thermopsis rhombifolia (Nutt. ex Pursh) Nutt. ex Richardson var. *annulocarpa* (A. Nelson) L.O. Williams **(6)** PH, VA; 730–1160 m; Gmg, Sss

Thermopsis rhombifolia (Nutt. ex Pursh) Nutt. ex Richardson var. *rhombifolia* **(85)** PH, VA; 620–1735 m; Flp, Fpj, Ftw, Gmg, Gup, Sjw, Sss, Wcb

Trifolium aureum* Pollich **(1) PH; 1475–1495 m; Gmm

Trifolium fragiferum* L. **(1) VA; 660 m; D

Trifolium hybridum* L. **(3) PH; 670–1350 m; Fmr, Fpp, Wpw

Trifolium pratense* L. **(2) PH; 1275–1495 m; D, Gmm

Trifolium repens* L. **(8) PH, VA; 660–1490 m; D, Fmc, Fmr

Vicia americana Muhl. ex Willd. var. *americana* **(8)** PH, VA; 665–1470 m; Fmr, Fpj

Vicia americana Muhl. ex Willd. var. *minor* Hook. **(122)** PH, VA; 620–1575 m; Fpj, Gmg, Gmm, Sgs, Sjw, Sss, Wcb

Gentianaceae

Gentiana affinis Griseb. **(1)** PH; 775–780 m; Wcb

Gentianella amarella (L.) Börner var. *acuta* (Michx.) Herder **(2)** PH; 1195–1285 m; Fmr

Geraniaceae

**Erodium cicutarium* (L.) L'Hér. ex Aiton; *W. Schultz s.n.* (MONT); VA

Geranium bicknellii Britton var. *longipes* (S. Watson) Fernald **(4)** PH; 1240–1645 m; Flp, Fmc, Fmr

Geranium carolinianum L. **(1)** PH; 1335–1370 m; Fmr

Geranium richardsonii Fisch. & Trautv. **(8)** PH; 1195–1490 m; Fmr

Geranium viscosissimum Fisch. & C.A. Mey. ex C.A. Mey. var. *viscosissimum* **(1)** VA; 925–960 m; Wcb

Grossulariaceae

Ribes americanum Mill. **(1)** PH; 1245 m; Fmr

Ribes aureum Pursh var. *aureum* **(3)** PH; 710–1365 m; Fmr, Ftw

Ribes aureum Pursh var. *villosum* DC. **(18)** PH, VA; 685–1370 m; Ftw, Gmg, Gup, Wcb

Ribes cereum Douglas **(26)** PH, VA; 725–1735 m; Fpj, Gup, Sjw, Vot

Ribes lacustre (Pers.) Poir. **(1)** PH; 1275–1350 m; Fmr

Ribes oxyacanthoides L. var. *irriguum* (Douglas) Jancz. **(1)** PH; 1395–1470 m; Fmr

Ribes oxyacanthoides L. var. *oxyacanthoides* **(16)** PH, VA; 680–1685 m; Fmr, Ftw, Sjw, Vot, Wcb

Haloragaceae

Myriophyllum sibiricum Kom. **(1)** PH; 930–935 m; Wpw

Myriophyllum verticillatum L. **(1)** VA; 925–960 m; Wpw

Hydrocharitaceae

♦ *Elodea bifoliata* H. St. John **(3)** PH; 775–935 m; Wpw

Iridaceae

Sisyrinchium montanum Greene var. *montanum* **(16)** PH, VA; 690–1685 m; Ftw, Gmg, Gmm, Wcb

Juncaceae

Juncus arcticus Willd. var. *balticus* (Willd.) Trautv. **(24)** PH, VA; 685–1145 m; Wal, Wcb, Wpw

Juncus bufonius L. **(7)** PH, VA; 640–880 m; Ftw, Wal, Wcb, Wpw

Juncus dudleyi Wiegand **(2)** PH, VA; 825–960 m; Wcb

Juncus interior Wiegand **(14)** PH, VA; 735–910 m; Wcb, Wpw

Juncus longistylis Torr. **(3)** PH, VA; 775–945 m; Wal, Wcb

Juncus torreyi Coville; *K.H. Lackschewitz 8626* (MONT, MONTU); PH

Juncaginaceae

Triglochin maritima L. (8) PH, VA; 685–1145 m; Wal, Wcb, Wpw

Lamiaceae

Dracocephalum parviflorum Nutt. (2) PH; 1290–1575 m; Fmr, Gmm

Hedeoma drummondii Benth. (2) PH, VA; 830–1145 m; Fmr, Fpj

Hedeoma hispidum Pursh (55) PH, VA; 620–1050 m; Fpj, Gmg, Sss, Wcb

**Leonurus cardiaca* L. var. *cardiaca*; *M. Andersen s.n.* (MONT); VA

Lycopus americanus Muhl. ex W.P.C. Barton (1) VA; 830–890 m; Wal

Lycopus asper Greene (12) PH, VA; 650–935 m; Wpw

Mentha arvensis L. (24) PH, VA; 685–1320 m; Fmr, Frc, Wpw

Monarda fistulosa L. var. *menthifolia* (Graham) Fernald (20) PH, VA; 780–1675 m; Flp, Fmc, Fmr, Fpp, Ftw, Wcb

**Nepeta cataria* L. (1) PH; 685 m; Ftw

**Salvia nemorosa* L.; *C. Dewit s.n.* (MONT); VA

Salvia reflexa Hornem. (1) VA; 650 m; Wpw

Stachys palustris L. var. *pilosa* (Nutt.) Fernald (5) PH, VA; 685–915 m; Wcb, Wpw

Liliaceae

Calochortus nuttallii Torr. & A. Gray (15) PH, VA; 690–1145 m; Fpj, Gmg, Gup, Sss

Fritillaria pudica (Pursh) Spreng. (5) PH; 720–1365 m; Fpj, Gmg, Gmm, Wcb

Prosartes trachycarpa S. Watson (16) PH, VA; 845–1490 m; Fmc, Fmr, Ftw

Streptopus amplexifolius (L.) DC. (2) PH; 1195–1350 m; Fmr

Linaceae

Linum australe A. Heller var. *australe* (23) PH, VA; 665–990 m; Gmg, Gup, Sss

Linum compactum A. Nelson (10) PH, VA; 660–830 m; Gmg, Gup, Sss

Linum lewisii Pursh var. *lewisii* (32) PH, VA; 675–1440 m; D, Ftw, Gmg, Gup, Wcb

Linum rigidum Pursh var. *rigidum* (5) PH, VA; 675–1050 m; Fpj, Gup, Sss

Loasaceae

Mentzelia albicaulis (Douglas ex Hook.) Douglas ex Torr. & A. Gray (4) PH, VA; 700–975 m; Fpj, Gmg, Vbl

Mentzelia decapetala (Pursh ex Sims) Urb. & Gilg ex Gilg (2) PH; 855–870 m; D, Vbl

Mentzelia dispersa S. Watson (9) PH, VA; 685–885 m; Fpj, Gmg, Sjw, Vbl

Mentzelia laevicaulis (Douglas ex Hook.) Torr. & A. Gray var. *laevicaulis*; *K.H. Lackschewitz 8365* (MONT); PH

♦*Mentzelia nuda* (Pursh) Torr. & A. Gray; *W.E. Booth s.n.* (MONT); VA

Lythraceae

♦ *Ammannia robusta* Heer & Regel (1) VA; 740–745 m; Wpw

Malvaceae

**Hibiscus trionum* L.; *S.A. Simonsen s.n.* (MONT); VA

**Malva parviflora* L.; *M.G. Atwater s.n.* (MONT); PH

**Malva sylvestris* L.; *R. Feigel s.n.* (MONT); PH

Sphaeralcea coccinea (Nutt.) Rydb. (74) PH, VA; 640–1145 m; D, Fpj, Gmg, Gup, Sgs, Sss

Melanthiaceae

Zigadenus venenosus S. Watson var. *gramineus* (Rydb.) O.S. Walsh ex M. Peck (50) PH, VA; 685–1575 m; Gmg, Sss, Wcb

Myrsinaceae

♦ *Anagallis minima* (L.) E.H.L. Krause (2) PH, VA; 780–910 m; Wcb, Wpw

Glaux maritima L. (3) PH, VA; 770–1145 m; Wal, Wcb

Lysimachia ciliata L. (3) PH; 1240–1490 m; Fmc, Fmr

Nyctaginaceae

Mirabilis linearis (Pursh) Heimerl var. *linearis* (10) PH, VA; 670–945 m; Fpj, Gmg, Gup, Sgs, Sjw, Sss

Oleaceae

Fraxinus pennsylvanica Marshall (15) PH, VA; 635–825 m; Frc, Ftw, Wcb, Wpw

Onagraceae

Chamerion angustifolium (L.) Holub var. *angustifolium* (1) PH; 1485–1735 m; Vot

Chamerion angustifolium (L.) Holub var. *canescens* (A.W. Wood) N.H. Holmgren & P.K. Holmgren (9) PH; 1270–1740 m; D, Fmr, Vot

Circaea alpina L. var. *alpina* (1) PH; 1275–1350 m; Fmr

Epilobium brachycarpum C. Presl (24) PH, VA; 675–1735 m; D, Fpp, Ftw, Gmg, Wcb, Wpw

Epilobium campestre (Jeps.) Hoch & W.L. Wagner (8) PH, VA; 675–915 m; Wcb, Wpw

Epilobium ciliatum Raf. var. *ciliatum* (13) PH, VA; 770–1350 m; Fmr, Wcb, Wpw

Epilobium ciliatum Raf. var. *glandulosum* (Lehm.) Dorn (2) PH; 1240–1320 m; Fmr

Epilobium glaberrimum Barbey var. *fastigiatum* (Nutt.) Trel. ex Jeps. (1) VA; 830–890 m; Wcb
Epilobium leptophyllum Raf. (3) PH, VA; 685–835 m; Wcb, Wpw
Gayophytum diffusum Torr. & A. Gray var. *strictipes* (Hook.) Dorn (1) PH; 1720–1740 m; D
Oenothera albicaulis Pursh (6) PH, VA; 710–845 m; Ftw, Gmg, Gup, Sss
Oenothera cespitosa Nutt. var. *cespitosa* (40) PH, VA; 620–990 m; Fpj, Gmg, Gup, Sgs, Sss, Vbl
Oenothera flava (A. Nelson) Garrett (1) VA; 650–660 m; Wcb
Oenothera nuttallii Sweet (2) VA; 680–750 m; Ftw, Gmg
Oenothera pallida Lindl. var. *trichocalyx* (Nutt.) Dorn; *J.W. Blankinship s.n.* (MONT); PH
Oenothera serrulata Nutt. (6) PH, VA; 680–945 m; Fpj, Ftw, Gmg, Sss, Wcb
Oenothera suffrutescens (Ser.) W.L. Wagner & Hoch (79) PH, VA; 620–1340 m; Fpj, Gmg, Gup, Sss, Vbl, Wcb
Oenothera villosa Thunb. var. *strigosa* (Rydb.) Dorn (9) PH, VA; 660–1740 m; D, Fmr, Frc, Wpw

Orchidaceae

Calypso bulbosa (L.) Oakes var. *americana* (R. Br.) Luer (1) PH; 1295–1325 m; Fmc
Coeloglossum viride (L.) Hartm. (2) PH; 1260–1450 m; Fmc, Fmr
Corallorhiza maculata (Raf.) Raf. var. *occidentalis* (Lindl.) Ames (4) PH; 1335–1735 m; Flp, Fmr
Corallorhiza striata Lindl. var. *striata* (4) PH; 1195–1440 m; Fmr, Fpp
Corallorhiza wisteriana Conrad (3) PH; 1195–1440 m; Fmr, Fpp
Cypripedium montanum Douglas ex Lindl. (4) PH; 1220–1370 m; Fmc, Fmr, Fpp
Goodyera oblongifolia Raf. (1) PH; 1275–1350 m; Flp
Platanthera aquilonis Sheviak (3) PH; 1245–1370 m; Fmr

Orobanchaceae

Castilleja miniata Douglas ex Hook. var. *miniata* (6) PH; 1240–1495 m; Fmr, Gmm
Castilleja sessiliflora Pursh (12) PH, VA; 665–1145 m; Fpj, Gmg, Sss
Orobanche fasciculata Nutt. (32) PH, VA; 620–990 m; Fpj, Gmg, Gup, Sss
Orthocarpus luteus Nutt. (48) PH, VA; 675–1365 m; Fpj, Ftw, Gmg, Sss, Wcb

Oxalidaceae

**Oxalis corniculata* L.; *C. Bergsagal s.n.* (MONT); PH
Oxalis dillenii Jacq. (2) VA; 880–910 m; Wcb, Wpw

Papaveraceae

Corydalis aurea Willd. var. *aurea* (3) PH; 1160–1735 m; D, Fmr, Vot
**Fumaria vaillantii* Loisel. (1) VA; 675–720 m; Ftw

Phrymaceae

Mimulus guttatus DC. (5) PH; 1195–1395 m; Fmr

Plantaginaceae

♦ *Bacopa rotundifolia* (Michx.) Wettst. (1) PH; 815–825 m; Wpw
Besseya wyomingensis (A. Nelson) Rydb. (2) PH; 955–1365 m; Fpp
Callitriche hermaphroditica L.; *J.W. Blankinship s.n.* (MONT), *K.H. Lackschewitz 8360* (MONT), *K.H. Lackschewitz 8577* (MONT, MONTU), *K.H. Lackschewitz 8616* (MONTU); PH, VA
Callitriche heterophylla Pursh var. *heterophylla* (3) VA; 800–910 m; Wpw
Callitriche palustris L. (1) PH; 770–790 m; Wpw
Collinsia parviflora Lindl. (2) PH; 1295–1440 m; Gmm
Gratiola neglecta Torr. (5) PH; 735–790 m; Wpw
Limosella aquatica L. (11) PH, VA; 740–935 m; Wpw
Penstemon albidus Nutt. (67) PH, VA; 620–1160 m; Gmg, Gup, Sss, Wcb
Penstemon eriantherus Pursh var. *eriantherus*; *W.E. Booth 59550* (MONT); VA
Penstemon gracilis Nutt. (12) PH, VA; 690–990 m; Gmg, Wcb
♦*Penstemon grandiflorus* Nutt.; *M. Flatt s.n.* (MONT); PH
Penstemon nitidus Douglas ex Benth. var. *nitidus* (62) PH, VA; 620–1675 m; Fpj, Gmg, Gmm, Gup, Sgs, Sjw, Sss, Vbl
Penstemon procerus Douglas ex Graham var. *procerus* (13) PH, VA; 790–1735 m; Fmr, Gmg, Gmm, Wcb
Plantago elongata Pursh var. *elongata* (46) PH, VA; 620–980 m; D, Gmg, Sgs, Sss, Wcb
**Plantago major* L. (11) PH, VA; 685–1350 m; D, Fmr, Wpw
Plantago patagonica Jacq. (83) PH, VA; 635–1145 m; D, Fpj, Gmg, Gup, Sgs, Sss
Veronica americana Schwein. ex Benth. (2) PH; 1195–1320 m; Fmr
**Veronica anagallis-aquatica* L.; *K.H. Lackschewitz 8592* (MONT, MONTU); PH
**Veronica catenata* Pennell (1) VA; 650 m; Wpw
Veronica peregrina L. var. *xalapensis* (Kunth) H. St. John & F.W. Warren (32) PH, VA; 640–935 m; Gmg, Wcb, Wpw

Poaceae

Achnatherum hymenoides (Roem. & Schult.) Barkworth (36) PH, VA; 670–1145 m; Fpj, Gmg, Gup, Sss
Achnatherum nelsonii (Scribn.) Barkworth ssp. *nelsonii* (2) PH, VA; 925–1340 m; D, Wcb
Achnatherum richardsonii (Link) Barkworth; *A.W. Armstrong 52* (USFS); PH
**Agropyron cristatum* (L.) Gaertn. var. *cristatum* (45) PH, VA; 635–1225 m; D, Ftw, Gmg, Sss
**Agropyron cristatum* (L.) Gaertn. var. *desertorum* (Fisch. ex Link) Dorn (54) PH, VA; 670–990 m; D, Gmg, Sgs, Sss
Agropyron cristatum* (L.) Gaertn. var. *fragile* (Roth) Dorn **(2) PH, VA; 700–825 m; D
Agropyron triticeum* Gaertn. **(1) VA; 665–690 m; Gmg
Agrostis exarata Trin. **(3)** PH; 1195–1245 m; Fmr
Agrostis scabra Willd. **(17)** PH, VA; 740–1740 m; D, Flp, Wcb, Wpw
Agrostis stolonifera* L. **(6) PH, VA; 685–1320 m; Fmr, Wcb, Wpw
Alopecurus aequalis Sobol. var. *aequalis* **(1)** VA; 730–810 m; Wpw
Alopecurus arundinaceus* Poir. **(11) PH, VA; 635–925 m; D, Wal, Wcb, Wpw
Alopecurus carolinianus Walter **(14)** PH, VA; 720–905 m; D, Wal, Wcb, Wpw
Alopecurus geniculatus* L. **(10) PH, VA; 740–930 m; Wcb, Wpw
Aristida purpurea Nutt. var. *longiseta* (Steud.) Vasey **(9)** PH, VA; 740–935 m; Gmg, Gup, Sss
Avena fatua* L. **(2) PH; 790–1225 m; D
Avenula hookeri (Scribn.) Holub **(3)** PH, VA; 925–1145 m; Fpp, Gmg
Beckmannia syzigachne (Steud.) Fernald **(38)** PH, VA; 635–935 m; Frc, Wcb, Wpw
Bouteloua gracilis (Kunth) Lag. ex Griffiths **(79)** PH, VA; 635–1050 m; Fpj, Gmg, Gup, Sgs, Sjw, Sss
Bromus ciliatus L. **(2)** PH; 1270–1395 m; Flp, Fmr
Bromus commutatus* Schrad. **(3) PH, VA; 690–905 m; D, Sss
Bromus inermis* Leyss. **(47) PH, VA; 635–1490 m; D, Fmr, Frc, Ftw, Gmg, Wcb, Wpw
Bromus japonicus* Thunb. ex Murray **(82) PH, VA; 620–1575 m; D, Fpj, Gmg, Sgs, Sjw, Sss, Wcb
Bromus porteri (J.M. Coult.) Nash **(3)** PH; 1320–1735 m; Fpp, Gmm
Bromus pumpellianus Scribn. **(3)** PH, VA; 660–1685 m; D, Fmc
Bromus richardsonii Link **(5)** PH; 1195–1740 m; D, Fmr
Bromus squarrosus* L. **(7) PH, VA; 640–905 m; D, Gmg, Sss
Bromus tectorum* L. **(37) PH, VA; 660–1735 m; D, Ftw, Gmg, Gmm, Gup, Sss
Buchloë dactyloides (Nutt.) Engelm.; *L. Lindgren s.n.* (MONT); VA
Calamagrostis canadensis (Michx.) P. Beauv. var. *canadensis* **(3)** PH; 1270–1470 m; Fmr

Calamagrostis inexpansa A. Gray **(1)** VA; 830–835 m; Wpw
Calamagrostis montanensis (Scribn.) Scribn. **(11)** PH, VA; 660–1145 m; Fpj, Fpp, Gmg, Sjw, Sss
Calamagrostis purpurascens R. Br. **(4)** PH; 1355–1735 m; Flp, Fmc, Gmm
Calamovilfa longifolia (Hook.) Scribn. var. *longifolia* **(31)** PH, VA; 685–975 m; Fpj, Gmg, Gup, Sgs, Sss
Cinna latifolia (Trevir. ex Göpp.) Griseb. **(1)** PH; 1195–1230 m; Fmr
Crypsis alopecuroides* (Piller & Mitterp.) Schrad. **(1) PH; 690 m; Frc
Danthonia spicata (L.) P. Beauv. ex Roem. & Schult. **(6)** PH; 1270–1675 m; Flp, Fmc, Fmr, Fpp
Danthonia unispicata (Thurb.) Munro ex Macoun **(4)** PH, VA; 790–930 m; Gmg, Wcb
Deschampsia cespitosa (L.) P. Beauv. var. *cespitosa* **(7)** PH, VA; 775–960 m; Wcb, Wpw
Distichlis spicata (L.) Greene **(25)** PH, VA; 675–1050 m; Sgs, Sss, Wal, Wpw
Echinochloa muricata (P. Beauv.) Fernald var. *microstachya* Wiegand **(23)** PH, VA; 650–935 m; D, Frc, Wpw
Elymus albicans (Scribn. & J.G. Sm.) Á. Löve **(5)** PH, VA; 755–1450 m; Fpj, Fpp, Gup
Elymus canadensis L. var. *canadensis* **(16)** PH, VA; 685–1145 m; Ftw, Wcb, Wpw
Elymus cinereus Scribn. & Merr. **(1)** PH; 705–730 m; D
Elymus elongatus* (Host) Runemark var. *ponticus* (Podp.) Dorn **(1) VA; 635–655 m; Gmg
Elymus elymoides (Raf.) Swezey var. *brevifolius* (J.G. Sm.) Dorn **(4)** PH; 740–820 m; Gmg, Gup, Sss
Elymus elymoides (Raf.) Swezey var. *elymoides* **(26)** PH, VA; 640–955 m; Gmg, Gup, Sgs, Sss
Elymus glaucus Buckley var. *glaucus* **(3)** PH; 1335–1495 m; Fmr, Gmm
Elymus hispidus* (Opiz) Melderis var. *hispidus* **(4) PH; 790–1740 m; D, Fmc
Elymus hispidus* (Opiz) Melderis var. *ruthenicus* (Griseb.) Dorn **(2) PH; 675–685 m; D, Frc
Elymus lanceolatus (Scribn. & J.G. Sm.) Gould var. *lanceolatus* **(19)** PH, VA; 730–1645 m; D, Gmg, Vbl
Elymus lanceolatus (Scribn. & J.G. Sm.) Gould var. *riparius* (Scribn. & J.G. Sm.) Dorn **(17)** PH, VA; 680–1450 m; D, Gmg
Elymus ×*macounii* Vasey **(1)** PH; 865–870 m; Gmg
Elymus repens* (L.) Gould **(19) PH, VA; 685–1470 m; Fmc, Fmr, Ftw, Sgs, Wcb, Wpw
Elymus ×*saundersii* Vasey **(2)** PH, VA; 805–835 m; D, Sgs
Elymus smithii (Rydb.) Gould **(121)** PH, VA; 620–1145 m; D, Fpj, Gmg, Sgs, Sjw, Sss, Vbl
Elymus spicatus (Pursh) Gould **(38)** PH, VA; 620–1735 m; Fmc, Fpj, Gmg, Gup, Sss
Elymus trachycaulus (Link) Gould ex Shinners ssp. *subsecundus* (Link) Á. Löve & D. Löve **(9)** PH, VA; 700–1735 m; Fmc, Fmr, Ftw, Gmg, Gmm, Gup, Wcb
Elymus trachycaulus (Link) Gould ex Shinners var. *trachycaulus* **(42)** PH, VA; 675–1685 m; D, Fpj, Fpp, Ftw, Gmg, Sgs, Vbl, Wcb, Wpw
Eragrostis cilianensis* (All.) Vignolo ex Janch. **(13) PH, VA; 660–830 m; D, Frc
Eragrostis hypnoides (Lam.) Britton, Sterns, & Poggenb. **(1)** PH; 690 m; Frc
Festuca campestris Rydb. **(1)** PH; 1380–1440 m; Gmm
Festuca hallii (Vasey) Piper **(1)** VA; 925–960 m; Gmg
Festuca saximontana Rydb. var. *saximontana* **(9)** PH, VA; 810–1735 m; Flp, Fpp, Gmg, Gmm
Glyceria grandis S. Watson var. *grandis*; *P. Lesica 8111* (MONTU); PH
Glyceria striata (Lam.) Hitchc. **(2)** PH; 1195–1320 m; Fmr
Hesperostipa comata (Trin. & Rupr.) Barkworth var. *comata* **(86)** PH, VA; 620–1145 m; Fpj, Gmg, Gup, Sgs, Sjw, Sss
Hesperostipa curtiseta (Hitchc.) Barkworth **(8)** PH, VA; 775–990 m; Ftw, Gmg
Hordeum jubatum L. ssp. *intermedium* Bowden **(59)** PH, VA; 635–1145 m; D, Gmg, Sgs, Sss, Vbl, Wal, Wcb, Wpw
Hordeum jubatum L. ssp. *jubatum* **(66)** PH, VA; 620–1740 m; D, Gmg, Sss, Wal, Wcb, Wpw
Hordeum pusillum Nutt. **(4)** PH; 705–790 m; D, Sgs, Sss
Hordeum vulgare* L. var. *vulgare* **(1) VA; 745–805 m; Ftw
Koeleria macrantha (Ledeb.) Schult. **(110)** PH, VA; 620–1735 m; Fpj, Gmg, Gmm, Gup, Sss, Wcb
**Leptochloa fusca* (L.) Kunth ssp. *fascicularis* (Lam.) N. Snow; *P. Lesica 4590* (MONTU), *D.W. Messer s.n.* (MONT); PH
**Lolium persicum* Boiss. & Hohen.; *S. Bradley s.n.* (MONT), *V.D. Luft s.n.* (MONT), *A. Solberg s.n.* (MONT), *Anonymous s.n.* (MONT); PH, VA
Muhlenbergia asperifolia (Nees & Meyen ex Trin.) Parodi **(1)** PH; 740–750 m; Wcb
Muhlenbergia cuspidata (Torr. ex Hook.) Rydb. **(2)** PH, VA; 670–730 m; Ftw, Gmg
Muhlenbergia racemosa (Michx.) Britton, Sterns, & Poggenb.; *J.W. Blankinship s.n.* (MONTU), *S.L. Bradley s.n.* (MONT); PH, VA
Muhlenbergia richardsonis (Trin.) Rydb. **(3)** PH, VA; 830–910 m; Wcb
Munroa squarrosa (Nutt.) Torr. **(10)** PH, VA; 670–825 m; D
Nassella viridula (Trin.) Barkworth **(100)** PH, VA; 620–1735 m; Fpj, Ftw, Gmg, Gmm, Gup, Sgs, Sjw, Sss, Wcb
Oryzopsis asperifolia Michx. **(4)** PH; 1270–1470 m; Flp, Fmc, Fmr
Panicum capillare L. ssp. *capillare* **(7)** PH, VA; 660–810 m; D, Frc, Wcb, Wpw
Phalaris arundinacea L. **(3)** PH, VA; 635–700 m; Frc, Wpw
Phleum alpinum L. var. *alpinum* **(1)** PH; 1395–1470 m; Fmr
Phleum pratense* L. var. *pratense* **(18) PH; 770–1685 m; D, Fmc, Fmr, Wcb, Wpw
Phragmites australis (Cav.) Trin. ex Steud. **(2)** PH, VA; 650–670 m; Frc, Wpw
Piptatherum micranthum (Trin. & Rupr.) Barkworth **(9)** PH, VA; 680–975 m; Fpj, Ftw, Sjw, Wcb
Poa arida Vasey **(27)** PH, VA; 660–990 m; Gmg, Sgs, Sss, Wcb, Wpw
Poa compressa* L. **(20) PH, VA; 685–1740 m; D, Flp, Fmr, Fpp, Wcb, Wpw
Poa cusickii Vasey var. *pallida* (Soreng) Dorn **(10)** PH, VA; 710–1005 m; Gmg, Sss, Wcb
Poa fendleriana (Steud.) Vasey ssp. *fendleriana* **(1)** VA; 880–920 m; Gmg
Poa glauca ssp. *glauca* **(1)** PH; 1485–1735 m; Vot
Poa interior Rydb. **(9)** PH; 955–1735 m; Flp, Fmc, Fmr, Fpp, Gmm
Poa nervosa var. *wheeleri* **(3)** PH; 1195–1645 m; Fmc, Fmr, Fpp
Poa palustris L. **(33)** PH, VA; 635–1645 m; Fmr, Ftw, Wcb, Wpw
Poa pratensis* L. **(92) PH, VA; 620–1735 m; D, Fmr, Ftw, Gmg, Gmm, Wcb, Wpw
Poa secunda J. Presl ssp. *juncifolia* (Scribn.) Soreng **(59)** PH, VA; 620–1685 m; Fpj, Gmg, Sgs, Sjw, Sss, Wcb, Wpw
Poa secunda J. Presl ssp. *secunda* **(67)** PH, VA; 620–990 m; Fpj, Gmg, Sgs, Sss, Wcb
Polypogon monspeliensis* (L.) Desf. **(12) PH, VA; 635–935 m; Frc, Wpw
Puccinellia distans (L.) Parl. **(1)** VA; 660 m; D
Puccinellia nuttalliana (Schult.) Hitchc. **(34)** PH, VA; 640–1145 m; Gmg, Sgs, Sss, Vbl, Wal, Wcb, Wpw
Schedonnardus paniculatus (Nutt.) Trel. **(14)** PH, VA; 640–970 m; D, Gmg, Sss
Schedonorus arundinaceus* (Schreb.) Dumort. **(1) PH; 1335–1370 m; Fmr
Schedonorus pratensis* (Huds.) P. Beauv. **(1) PH; 1240–1320 m; Fmr
Schizachne purpurascens (Torr.) Swall. **(2)** PH; 1275–1470 m; Flp, Fmr
Schizachyrium scoparium (Michx.) Nash var. *scoparium* **(17)** PH, VA; 685–1365 m; Ftw, Gup, Sjw, Sss

Setaria viridis* (L.) P. Beauv. **(7) PH, VA; 650–870 m; D, Frc
Spartina gracilis Trin. **(14)** PH, VA; 680–945 m; Wal, Wcb, Wpw
Spartina pectinata Link **(12)** PH, VA; 690–1145 m; Wal, Wcb, Wpw
♦ *Sphenopholis intermedia* (Rydb.) Rydb. **(1)** PH; 1355–1390 m; Fmc
Sphenopholis obtusata (Michx.) Scribn. **(1)** PH; 790–795 m; Wpw
Sporobolus airoides (Torr.) Torr. **(1)** PH; 955–1145 m; Wal
Sporobolus cryptandrus (Torr.) A. Gray **(5)** PH, VA; 660–825 m; D, Gmg
Triticum aestivum* L. **(3) PH, VA; 745–835 m; D, Vbl
Vulpia octoflora (Walter) Rydb. var. *glauca* (Nutt.) Fernald **(7)** PH, VA; 670–840 m; Gmg, Gup, Sss
Vulpia octoflora (Walter) Rydb. var. *octoflora* **(22)** PH, VA; 660–855 m; Gmg, Sss

Polemoniaceae
Collomia linearis Nutt. (88) PH, VA; 620–1740 m; D, Fpj, Gmg, Gup, Sgs, Sjw, Sss, Wcb
Leptosiphon septentrionalis (H. Mason) J.M. Porter & L.A. Johnson (2) PH, VA; 775–865 m; Gmg, Sss
Navarretia saximontana S.C. Spencer (8) PH, VA; 650–910 m; Wcb, Wpw
Phlox alyssifolia Greene (9) PH, VA; 670–1440 m; Fmc, Fpp, Ftw, Gmg, Gup, Sjw
♦ *Phlox andicola* E.E. Nelson (1) PH; 940–980 m; Sss
Phlox hoodii Richardson (43) PH, VA; 655–1440 m; Gmg, Gup, Sgs, Sss

Polygalaceae
Polygala alba Nutt. (10) PH, VA; 660–890 m; Gmg, Wcb
Polygala verticillata L. (2) PH, VA; 730–815 m; Fpj

Polygonaceae
Eriogonum cernuum Nutt. (2) VA; 730–880 m; Gup
Eriogonum flavum Nutt. var. *flavum* (50) PH, VA; 640–1145 m; Gmg, Gup, Sss
Eriogonum ovalifolium Nutt. var. *ochroleucum* (Small ex Rydb.) M. Peck (5) PH; 850–1145 m; Fpj, Gmg, Gup
Eriogonum ovalifolium Nutt. var. *purpureum* (Nutt.) T. Durand (1) PH; 1485–1735 m; Vot
Eriogonum pauciflorum Pursh (55) PH, VA; 670–1050 m; Fpj, Gmg, Gup, Sgs, Sss, Vbl
Eriogonum umbellatum Torr. var. *majus* Hook.; *A.W. Armstrong 27* (USFS); PH
**Fallopia convolvulus* (L.) Á. Löve (25) PH, VA; 650–1145 m; D, Frc, Ftw, Gmg, Wcb, Wpw
Persicaria amphibia (L.) Gray (27) PH, VA; 635–935 m; Wcb, Wpw
Persicaria lapathifolia (L.) Gray (11) PH, VA; 650–935 m; Wcb, Wpw
**Persicaria maculosa* Gray (1) PH; 675–680 m; Ftw
Polygonum achoreum S.F. Blake (8) PH, VA; 650–905 m; D
**Polygonum aviculare* L. (106) PH, VA; 620–1740 m; D, Gmg, Sgs, Sjw, Sss, Vbl, Wal, Wcb, Wpw
Polygonum douglasii Greene (16) PH, VA; 675–1575 m; Ftw, Gmg, Wcb
Polygonum erectum L. (2) PH, VA; 705–975 m; D, Sgs
Polygonum ramosissimum Michx. var. *ramosissimum* (13) PH, VA; 635–935 m; Fpj, Gmg, Wcb
Rumex crispus* L. **(12) PH, VA; 740–1320 m; Fmr, Wcb, Wpw
Rumex fueginus Phil. **(4)** PH, VA; 635–825 m; Wpw
Rumex occidentalis S. Watson **(2)** VA; 830–905 m; Wcb, Wpw
Rumex patientia* L. **(4) PH, VA; 650–870 m; Wcb, Wpw
Rumex stenophyllus* Ledeb. **(24) PH, VA; 635–905 m; Wal, Wcb, Wpw
Rumex triangulivalvis (Danser) Rech. f. **(26)** PH, VA; 670–1740 m; Wcb, Wpw
Rumex utahensis Rech. f. **(19)** PH, VA; 650–910 m; Ftw, Wcb, Wpw
Rumex venosus Pursh **(2)** VA; 665–845 m; Gmg

Portulacaceae
Lewisia rediviva Pursh **(1)** PH; 785 m; Gmg
Portulaca oleracea* L. **(3) PH, VA; 675–825 m; D

Potamogetonaceae
Potamogeton diversifolius Raf. **(1)** PH; 815–825 m; Wpw
Potamogeton foliosus Raf. var. *foliosus*; *K.H. Lackschewitz 8602* (MONT), *K.H. Lackschewitz 8614* (MONT, MONTU); PH
Potamogeton friesii Rupr.; *P. Lesica 3134* (MONTU, RM); PH
Potamogeton pusillus L. var. *pusillus* **(1)** VA; 830–890 m; Wpw
Potamogeton richardsonii (A. Benn.) Rydb. **(7)** PH, VA; 775–960 m; Wpw
Potamogeton zosteriformis Fernald **(1)** PH; 810 m; Wpw
Stuckenia pectinata (L.) Börner **(8)** PH, VA; 675–935 m; Wpw
Zannichellia palustris L. **(1)** PH; 690–700 m; Wpw

Primulaceae
Androsace occidentalis Pursh (31) PH, VA; 620–1365 m; Gmg, Sss, Wcb
Androsace septentrionalis L. (15) PH, VA; 735–925 m; Gmg, Wcb
Primula conjugens (Greene) A.R. Mast & Reveal var. *conjugens* (2) PH; 1195–1370 m; Fpp, Gmm
Primula pauciflora (Greene) A.R. Mast & Reveal var. *pauciflora* (1) VA; 925–960 m; Wcb

Ranunculaceae
Actaea rubra (Aiton) Willd. (8) PH; 1195–1490 m; Fmc, Fmr
Anemone cylindrica A. Gray (5) PH; 1195–1485 m; Flp, Fmc, Fmr
Anemone multifida Poir. var. *multifida* (12) PH, VA; 680–1735 m; Fmc, Fmr, Fpp, Ftw, Gmm
Anemone patens L. var. *multifida* Pritz. (16) PH, VA; 670–1440 m; Fpp, Gmg, Gmm, Wcb
Clematis columbiana (Nutt.) Torr. & A. Gray var. *tenuiloba* (A. Gray) J.S. Pringle (1) PH; 1255–1440 m; Fpp
Clematis ligusticifolia Nutt. (4) PH, VA; 650–750 m; Frc, Ftw
Clematis occidentalis (Hornem.) DC. var. *grosseserrata* (Rydb.) J.S. Pringle (13) PH; 1195–1490 m; Flp, Fmc, Fmr
Delphinium bicolor Nutt. ssp. *bicolor* (5) PH, VA; 880–1440 m; Fmr, Gmg, Gmm
Myosurus minimus L. (8) PH, VA; 690–830 m; Wcb, Wpw
Ranunculus abortivus L. (2) PH; 1195–1320 m; Fmr
Ranunculus aquatilis L. var. *diffusus* With. (7) PH, VA; 770–1320 m; Fmr, Wpw
Ranunculus cymbalaria Pursh (12) PH, VA; 650–960 m; Wal, Wcb, Wpw
Ranunculus glaberrimus Hook. var. *ellipticus* (Greene) Greene (3) VA; 820–925 m; Wcb
♦ *Ranunculus hyperboreus* Rottb. (1) VA; 830–835 m; Wpw
Ranunculus macounii Britton (6) PH, VA; 830–1350 m; Fmr, Wpw
**Ranunculus testiculatus* Crantz (1) VA; 725 m; D
Thalictrum occidentale A. Gray (5) PH, VA; 780–1470 m; Fmr, Ftw
Thalictrum venulosum Trel. (2) PH; 800–1285 m; Fmr, Ftw

Rhamnaceae
Ceanothus velutinus Douglas ex Hook. var. *velutinus* (4) PH; 1250–1735 m; Flp, Fmc, Vot

Rosaceae
Agrimonia striata Michx. (6) PH; 885–1395 m; Fmr, Ftw
Amelanchier alnifolia (Nutt.) Nutt. ex M. Roem. var. *alnifolia* (19) PH, VA; 685–1575 m; Fmr, Fpp, Ftw
Chamaerhodos erecta (L.) Bunge var. *parviflora* (Nutt.) C.L. Hitchc. (10) PH, VA; 640–1450 m; Gmg, Gup, Sss, Vot
**Cotoneaster lucidus* Schltdl. (1) VA; 830–835 m; D
Crataegus chrysocarpa Ashe var. *chrysocarpa* (4) PH; 895–1440 m; Fmr, Ftw
Crataegus macracantha Lodd. ex Loudon var. *occidentalis* (Britton) Eggl. (1) PH; 1295–1325 m; Fmr
Dasiphora fruticosa (L.) Rydb. (19) PH, VA; 845–1740 m; Flp, Fmc, Fmr, Fpp, Ftw, Gmg, Gmm, Vot, Wcb

Drymocallis arguta (Pursh) Rydb. (20) PH, VA; 620–1575 m; Fmc, Ftw, Gmg, Sss, Wcb
Drymocallis glabrata Rydb. (11) PH; 805–1735 m; Flp, Fmc, Fmr, Fpp, Gmm
Fragaria vesca L. (1) VA; 870–910 m; Wcb
Fragaria virginiana Mill. **(9)** PH; 1195–1575 m; Flp, Fmc, Fmr, Fpp
Geum aleppicum Jacq. **(9)** PH, VA; 775–1395 m; Fmr, Ftw, Wcb
Geum macrophyllum Willd. var. *perincisum* (Rydb.) Raup **(3)** PH; 1220–1350 m; Flp, Fmr
Geum triflorum Pursh var. *triflorum* **(61)** PH, VA; 660–1575 m; Fpj, Fpp, Ftw, Gmg, Gmm, Sss, Wcb
Malus pumila* Mill. **(1) PH; 685–690 m; D
Potentilla anserina L. **(8)** PH, VA; 650–960 m; Wcb, Wpw
Potentilla biennis Greene; *M. Lavin s.n.* (MONT); PH
Potentilla bipinnatifida Douglas ex Hook. var. *bipinnatifida* **(37)** PH, VA; 640–970 m; Gmg, Gup, Wcb
Potentilla concinna Richardson var. *concinna* **(15)** PH, VA; 695–1440 m; Gmg, Wcb
Potentilla gracilis Douglas ex Hook. var. *elmeri* (Rydb.) Jeps. **(2)** VA; 685–960 m; Wcb
Potentilla gracilis Douglas ex Hook. var. *fastigiata* (Nutt.) S. Watson **(6)** PH, VA; 690–990 m; Ftw, Gmg, Wcb
Potentilla gracilis Douglas ex Hook. var. *pulcherrima* (Lehm.) Fernald **(18)** PH, VA; 740–1495 m; Fmr, Ftw, Gmm
Potentilla hippiana Lehm. var. *effusa* (Douglas ex Lehm.) Dorn **(6)** PH; 955–1735 m; Flp, Fmc, Gmm, Gup, Vot
Potentilla hippiana Lehm. var. *hippiana* **(15)** PH, VA; 755–960 m; Gmg, Sss, Wcb
Potentilla norvegica L. ssp. *monspeliensis* (L.) Asch. & Graebn. **(9)** PH, VA; 770–1645 m; D, Fmc, Fmr, Wcb, Wpw
Potentilla paradoxa Nutt.; *W.E. Booth 57633* (MONT), *K.H. Lackschewitz 8063* (MONT, MONTU), *P. Lesica 4593* (MONTU), *P. Lesica 7835* (MONTU); PH, VA
Potentilla pensylvanica L. var. *pensylvanica* **(12)** PH, VA; 725–1145 m; Gmg, Gup, Sss, Wcb
♦*Potentilla plattensis* Nutt.; *P. Lesica 9186* (MONTU); VA
Potentilla rivalis Nutt. var. *millegrana* (Engelm. ex Lehm.) S. Watson **(3)** PH, VA; 635–865 m; Wpw
Prunus americana Marshall **(1)** VA; 830–835 m; Wcb
Prunus pensylvanica L. f. **(10)** PH; 845–1685 m; Fmc, Fmr, Ftw, Vot
Prunus virginiana L. var. *melanocarpa* (A. Nelson) Sarg. **(62)** PH, VA; 635–1735 m; Fmr, Fpp, Frc, Ftw, Wcb
Rosa arkansana Porter var. *arkansana* **(10)** PH, VA; 675–955 m; Fpj, Ftw, Gmg, Gup
Rosa arkansana Porter var. *suffulta* (Greene) Cockerell **(33)** PH, VA; 685–1450 m; Fmc, Fpj, Fpp, Ftw, Gmg, Sss, Wcb, Wpw
Rosa nutkana C. Presl var. *hispida* Fernald **(10)** PH, VA; 830–1735 m; Flp, Fmr, Fpj, Ftw, Vot
Rosa sayi Schwein. **(41)** PH, VA; 620–1575 m; Fmr, Gmg, Gup, Sjw, Sss
Rosa woodsii Lindl. var. *woodsii* **(83)** PH, VA; 650–1675 m; D, Fpj, Frc, Ftw, Gmg, Gup, Wcb, Wpw
Rubus idaeus L. var. *aculeatissimus* Regel & Tiling **(17)** PH, VA; 845–1740 m; Fmc, Fmr, Ftw, Vot
Rubus parviflorus Nutt. var. *parviflorus* **(1)** PH; 1270–1395 m; Flp
Spiraea betulifolia Pall. var. *lucida* (Douglas ex Hook.) C.L. Hitchc. **(15)** PH; 1195–1740 m; Flp, Fmc, Fmr, Fpp

Rubiaceae
Galium aparine L. **(9)** PH, VA; 685–1145 m; Ftw, Wcb
Galium boreale L. **(27)** PH, VA; 770–1735 m; Flp, Fmc, Fmr, Fpp, Ftw, Gmg, Gmm
Galium triflorum Michx. **(12)** PH, VA; 755–1735 m; Fmc, Fmr, Ftw

Salicaceae
Populus angustifolia E. James (1) PH; 1290–1340 m; Fmr
Populus balsamifera L. var. *balsamifera* (3) PH; 685–1340 m; Fmr
Populus ×*brayshawii* B. Boivin (2) PH; 1245–1440 m; Fmr
Populus deltoides W. Bartram ex Marshall var. *occidentalis* Rydb. (45) PH, VA; 635–1370 m; Frc, Ftw, Wcb, Wpw
Populus tremuloides Michx. (26) PH, VA; 845–1685 m; Fmc, Fmr, Fpp, Ftw
Salix amygdaloides Andersson (35) PH, VA; 635–960 m; Frc, Wpw
Salix bebbiana Sarg. (7) PH; 1195–1440 m; Fmr
Salix eriocephala Michx. var. *famelica* (C.R. Ball) Dorn (6) PH, VA; 650–890 m; Frc, Ftw, Wpw
Salix eriocephala Michx. var. *watsonii* (Bebb) Dorn (2) VA; 680–865 m; Wcb
Salix exigua Nutt. ssp. *exigua*; *K.H. Lackschewitz 8148* (MONT, MONTU); PH
Salix exigua Nutt. ssp. *interior* (Rowlee) Cronquist (26) PH, VA; 650–960 m; Frc, Wpw
**Salix fragilis* L. (1) VA; 830–835 m; Wcb
Salix scouleriana Barratt ex Hook. (9) PH; 1245–1735 m; Flp, Fmc, Fmr

Santalaceae
Comandra umbellata (L.) Nutt. var. *pallida* (A. DC.) M.E. Jones (79) PH, VA; 620–1440 m; Fpj, Gmg, Gup, Sjw, Sss

Sapindaceae
Acer negundo L. var. *interius* (Britton) Sarg. (11) PH, VA; 635–970 m; Frc, Ftw, Wpw
Acer negundo L. var. *violaceum* (Kirchn.) Jacq. (1) PH; 675–685 m; Frc

Sarcobataceae
Sarcobatus vermiculatus (Hook.) Torr. (69) PH, VA; 620–1005 m; Fpj, Sgs, Sss, Vbl

Saxifragaceae
Heuchera parvifolia Nutt. ex Torr. & A. Gray (4) PH; 955–1735 m; Fmr, Fpp, Vot
Heuchera richardsonii R. Br. (7) VA; 770–990 m; Ftw, Gmg, Wcb
Lithophragma parviflorum (Hook.) Nutt. ex Torr. & A. Gray (1) PH; 1245–1370 m; Fmr
Saxifraga occidentalis S. Watson (1) PH; 1585–1645 m; Fmr

Scrophulariaceae
**Verbascum thapsus* L. (5) PH; 1225–1740 m; D, Fmr

Smilacaceae
Smilax lasioneura Hook.; *L. Thompson 1873* (MONTU); PH

Solanaceae
**Lycium barbarum* L.; *V. Koenig s.n.* (MONT), *D. Skybery s.n.* (MONT); VA
Physalis longifolia Nutt.; *A.G. Thorsen s.n.* (MONT); VA
**Solanum physalifolium* Rusby var. *nitidibaccatum* (Bitter) Edmonds; *Anonymous s.n.* (MONT); VA
Solanum rostratum Dunal; *J.W. Blankinship s.n.* (MONT), *V. Koenig s.n.* (MONT); VA
Solanum triflorum Nutt. (8) PH, VA; 650–930 m; D, Ftw, Gmg

Tamaricaceae
*● *Tamarix chinensis* Lour. (3) VA; 685–785 m; Wcb, Wpw

Typhaceae
Sparganium eurycarpum Engelm. ex A. Gray; *J. Berger s.n.* (MONT); VA
Typha angustifolia L. (4) PH, VA; 675–835 m; Wpw
Typha ×*glauca* Godr.; *M.G. Atwater s.n.* (MONT); PH
Typha latifolia L. (12) PH, VA; 670–930 m; Wpw

Ulmaceae
Ulmus americana L. (1) PH; 685–690 m; D
**Ulmus pumila* L. (2) VA; 660–835 m; D

Urticaceae

Parietaria pensylvanica Muhl. ex Willd. (30) PH, VA; 675–1145 m; Fmr, Fpj, Ftw, Sgs

Urtica dioica L. var. *procera* (Muhl. ex Willd.) Wedd. (16) PH, VA; 650–1275 m; Frc, Ftw, Wcb, Wpw

Verbenaceae

Verbena bracteata Lag. & Rodr. (14) PH, VA; 650–935 m; D

Violaceae

Viola adunca Sm. var. *adunca* (5) PH; 1195–1440 m; Flp, Fmc, Fmr, Fpp

Viola canadensis L. (10) PH, VA; 950–1470 m; Fmr, Ftw, Gmm

Viola nephrophylla Greene (1) VA; 925–960 m; Wcb

Viola nuttallii Pursh (35) PH, VA; 620–1440 m; Fpj, Gmg, Gup, Sjw, Sss, Wcb

Viola vallicola A. Nelson (15) PH, VA; 710–1440 m; Gmg, Gmm, Wcb

Vitaceae

Parthenocissus vitacea (Knerr) Hitchc.; *B. Cornwell s.n.* (MONT); VA

Zygophyllaceae

**Peganum harmala* L.; *J.H. Rumely s.n.* (MONT), *J. Yeska s.n.* (MONT), *M. Yeska s.n.* (MONT); PH, VA

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TAXONOMIC IDENTITY AND HISTORICAL ACCOUNTS OF *DALEA CYLINDRICEPS* (FABACEAE), A SPECIES OF CONSERVATION CONCERN IN THE GREAT PLAINS (U.S.A.)

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ABSTRACT

Dalea cylindriceps Barneby (Fabaceae) is a perennial herb native to the western Great Plains of North America. Despite a large area of historical distribution, *D. cylindriceps* has been collected infrequently and is a species of conservation concern. This species has a complex nomenclatural history, clarification of which enabled search of floristic and ecological literature for information on distribution, abundance, and ecological associations. *Dalea cylindriceps* is associated with sandy habitat and in the central Great Plains is often associated with sandsage prairie, a steppe community type dominated by the shrub *Artemisia filifolia*. Further study of *D. cylindriceps* is warranted for the conservation of the species, and holds promise for enhanced understanding of the ecology and dynamics of sandsage prairie, a plant community that is of conservation concern throughout most of its distribution in the Great Plains.

RESUMEN

Dalea cylindriceps Barneby (Fabaceae) es una hierba perenne nativa del oeste de las Grandes Llanuras de Norte América. A pesar de la gran área de distribución histórica, *D. cylindriceps* ha sido colectada con poca frecuencia y es una especie de preocupación en su conservación. Esta especie tiene una historia nomenclatural compleja, cuya clarificación necesita la búsqueda de bibliografía florística y ecológica para la información sobre su distribución, abundancia, y asociaciones ecológicas. *Dalea cylindriceps* se asocia con hábitats arenosos y en las Grandes Llanuras centrales está a menudo asociada con paraderas de Artemisia, un tipo de comunidad de estepa dominada por el arbusto *Artemisia filifolia*. Se necesita más estudio de *D. cylindriceps* para la conservación de la especie, y contiene la promesa para un conocimiento mejorado de la ecología y dinámica de la pradera, una comunidad vegetal que es de preocupación por su conservación en la mayoría de su distribución en las Grandes Llanuras.

INTRODUCTION

Dalea cylindriceps Barneby (Fabaceae) is a perennial herb (Figs. 1 & 2) native to the western Great Plains of North America. Occurrences are known from the states of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming. Despite the large extent of its historical distribution, *D. cylindriceps* has been collected infrequently and occurrences are scattered and local. As noted in the recent *Flora of Nebraska* (Kaul et al. 2011), "This distinctive species is rare almost throughout its wide geographic range." *Dalea cylindriceps* is tracked as a species of conservation concern in all but two of the states in which it has been documented, and is ranked by NatureServe (2013) as G3G4 (vulnerable).

Initial field survey by the author in the northern part of the range of *D. cylindriceps* indicates this species may have experienced considerable population decline. In 2010, I searched the sites of 22 historical occurrences of *D. cylindriceps* (derived from herbarium specimen locality data) in Colorado, Nebraska, and Wyoming and found existing populations at only 4 sites. It should be noted that *D. cylindriceps* is a relatively large plant (generally 3–6 [up to 8] dm tall) with distinctively elongate (up to 18 cm long) flowering spikes, making it a noticeable object in the landscape.

Analysis of floristic and ecological literature informs conservation assessment by yielding historical information on distribution, abundance, ecological associations, etc. In the case of *D. cylindriceps*, such an analysis is made difficult by the complex nomenclatural history of this taxon. Clarification of the nomenclature used for this species will allow for more accurate assessment of its conservation status.

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Fig. 1. Illustration of *Dalea cylindriceps*, reproduced from *Common Legumes of the Great Plains: An Illustrated Guide* by James Stubbendieck and Elverne C. Conard, illustrated by Bellamy Parks Jansen, by permission of the University of Nebraska Press, copyright 1989 by the University of Nebraska Press.

Fig. 2. ***Dalea cylindriceps*****, Sheridan County, Nebraska. Photo James Locklear.**

Taxonomic Identity

The taxonomic history of this species was reviewed by Barneby (1977) in his monograph on the genus *Dalea* L., in which he determined that a new binomial was required and proposed the currently accepted name, *D. cylindriceps* Barneby.

The earliest published name for this taxon is *Petalostemum macrostachyum* Torr., described in 1827 from material collected in 1820 by Edwin James in present-day Nebraska (see below). In *Flora of North America*, Torrey and Gray (1838, p. 309) altered the rendering of the generic name to *Petalostemon* (giving the full binomial as *Petalostemon macrostachyum*) and listed *P. ornatum* Douglas ex Hook. as a synonym. Gray later (1848) distinguished *P. ornatum* from *P. macrostachyum*, and the former is now recognized as *Dalea ornata* (Douglas) Eaton & Wright, a species of the Columbia Plateau and northern Great Basin. This early taxonomic confusion resulted in *P. macrostachyum* being treated in certain 19th century botanical literature as a plant of the Pacific Northwest as well as the Great Plains (e.g., Coulter 1885).

Torrey and Gray later (1840, p. 690) added *Dalea compacta* Spreng. as a synonym under *P. macrostachyum* but, as determined by Barneby (1977), *D. compacta* is a separate species that occurs in eastern Texas and adjacent Arkansas and Oklahoma. Misinterpretation of *D. compacta*, along with misapplication of the specific epithet, has been at the root of much of the nomenclatural confusion surrounding *D. cylindriceps* (Peterson 2000).

Torrey's *Petalostemum macrostachyum* (correctly rendered *Petalostemon macrostachyus* in accord with the masculine gender of *Petalostemon*) appears in the early botanical literature of the Great Plains region (Eastwood 1893; Engelmann 1862; Gray 1848, 1863; Parry 1870; Porter & Coulter 1874), but subsided after publica-

tion of *Petalostemon compactus* (Spreng.) Swezey in 1891 in *Nebraska Flowering Plants* (Doane College Natural History Studies No. 1), a 17-page pamphlet written by Goodwin D. Swezey, professor at Doane College in Crete, Nebraska. Swezey cited "*P. macrostachyus* Torr." as a replaced synonym of his *P. compactus*. While proposed in a relatively obscure publication, Swezey's name apparently gained recognition and adoption thanks to the review of his pamphlet by Nathaniel Lord Britton (1891) published in the widely-circulated *Bulletin of the Torrey Botanical Club*.

Swezey's *P. compactus* was a new combination based on *D. compacta* (Sprengel 1826), which Torrey and Gray (1840, p. 690) included in the concept of *Petalostemon macrostachyum* (Torrey 1827) but which Swezey elevated based on prior publication. It should be noted that Swezey applied the name *P. compactus* to specimens of what is in fact *D. cylindriceps*. Two such specimens are known to the author. One is in the herbarium of Doane College in Crete, Nebraska, collected by E.E. Sprague (*s.n.*) on 25 July 1890 near Lewellen in Garden County, Nebraska (annotated by S. Rolfsmeier [1987] as *D. cylindriceps*). The other is at NY (1259224) and appears to be a duplicate of the Sprague collection (with same collection date and locality) distributed under an "Herb. of G.D. Swezey" label (annotated by D. Isely [1958] and D. Wemple [1961–1965] as "*P. compactum*").

Further clouding the nomenclature of this taxon was the reduction of *Petalostemon* Michx. and *Dalea* L. to the genus *Kuhnistera* Lam. by Kuntze (1891), in which he proposed *K. compacta* (Spreng.) Kuntze, under which he placed *D. compacta* and "*Petalostemon macrostachyum*" as synonyms. Heller later (1896) added "*Petalostemon compactus* Swezey" to the list of synonyms under *K. compacta*. Use of the name *K. compacta* for what is clearly *D. cylindriceps* occurred in a number of botanical and ecological publications in Great Plains states (Hitchcock 1896; Pound & Clements 1900; Saunders 1899).

The publications of Per Axel Rydberg were foundational to state and regional treatments of the flora of the Great Plains in the first part of the 20th century. Regarding *D. cylindriceps*, Rydberg initially (1894, 1895) took up *K. compacta* for the taxon, citing *Petalostemon macrostachyus* and *D. compacta* as synonyms, but subsequently adopted *Petalostemon compactus* (Spreng.) Swezey, first in *Flora of Colorado* (1906), then in *Flora of the Rocky Mountains and Adjacent Plains* (1917) and *Flora of the Prairies and Plains of Central North America* (1932). During this same period, Britton and Brown (1897) treated this taxon as *K. compacta* but later (1913) adopted Swezey's name, rendering it "*Petalostemum compactum* (Spreng.) Swezey."

Subsequent treatments of this taxon in the flora of the Great Plains region followed Rydberg in using Swezey's *Petalostemon compactus* (often rendered *P. compactum*). These include floristic and ecological works for the states of Colorado (Harrington 1954; Ramaley 1939), Kansas (Bare 1979; Barkley 1968; Gates 1940), Nebraska (Petersen 1923; Webber 1892), New Mexico (Wooton & Standley 1915; Martin & Hutchins 1980), Texas (Correll & Johnston 1970; Turner 1959), and Wyoming (Dorn 1977b), as well as other regional literature (Barr 1983; Coulter & Nelson 1909; Dorn 1977a; Rogers 1953) including *Atlas of the Flora of the Great Plains* (GPFA 1977).

The taxonomic identity and nomenclatural problems associated with *P. compactus* (Spreng.) Swezey received further consideration and clarification in the 1970s. In his revision of the genus *Petalstemon*, Wemple (1970) recognized "*Petalostemon compactum* (Spreng.) Swezey," treating both *P. macrostachyum* and *D. compacta* as synonyms. But, in his monograph on the genus *Dalea*, Barneby (1977) separated *D. compacta* from the taxon originally described as *P. macrostachyum*, which excluded the type of *D. compacta* from his concept of *P. macrostachyum*, making the latter the oldest available name for the species. Since Barneby was reducing the genus *Petalostemon* to *Dalea*, he needed to transfer *P. macrostachyum* to *Dalea*, but there was already a *D. macrostachya* Moric., necessitating the "unwelcome new epithet" of *cylindriceps*. *Dalea cylindriceps* was adopted in *Flora of the Great Plains* (GPFA 1986) and has since been used in most treatments of the flora of the region (Dorn 2001; Kaul et al. 2011; Turner et al. 2003; Van Bruggen 1985; Weber & Wittmann 2012). Correct nomenclature and synonymy for this species is provided below.

Dalea cylindriceps Barneby, Mem. New York Bot. Gard. 27:227. 1977. Type: United States: "Long's 1st Expedition. Dr. James" [as on label], *E. James s.n.* (holotype: NY [26677], internet image!). Collection locality and date not stated but along or near South Platte River in Lincoln County, Nebraska, 22–23 Jun 1820.

Petalostemon macrostachyus Torr. [originally published as *Petalostemum macrostachyum* Torr.], Ann. Lyceum Nat. Hist. New York 2:176–177. 1827. Not *Dalea macrostachya* Moric., Pl. Nouv. Amer. 6. t. 5. 1833. Not *Petalostemon macrostachyum* sensu Torr. & A. Gray, Fl. N. Amer. [Torr. & A. Gray] 1:309. 1838.

Petalostemon compactus sensu Swezey, Neb. Fl. Pl. (Doane Coll. Nat. Hist. Soc.) 1:6, 1891. Not *Dalea compacta* Spreng., Syst. Veg. (ed. 16) [Sprengel] 3:327. 1826. Not *Kuhnistera compacta* (Spreng.) Kuntze, Rev. Gen. Pl. 192. 1891.

Discovery and Type Locality

The type specimen of what would eventually be recognized as *D. cylindriceps* was collected by Edwin James while traveling with the Stephen H. Long Expedition of 1820. In his enumeration of the botany of the expedition, Torrey (1827) stated the locality of James' collection of *Petalostemum macrostachyum* as "About the forks of the Platte." No date or locality information is provided on the holotype (the only known specimen) at NY (Fig. 3), only the statement, "Long's 1st Expedition. Dr. James." James did not mention this species in either his published account of the expedition (James 1823) or in his personal diary (Goodman & Lawson 1995).

The North and South Platte rivers ("the forks of the Platte") join to form the Platte River in Lincoln County, Nebraska, just east of the city of North Platte. From here westward to Ogallala, Nebraska (a distance of ca. 70 km), the main channels of the North and South Platte rivers run within a few (5–6) kilometers of each other until they begin to diverge about 18 km east of Ogallala, the North Platte to the northwest and the South Platte to the southwest. Thus, "About the forks of the Platte" could be a general description of the area between North Platte and Ogallala, which the expedition traversed 22–25 June 1820 (Goodman & Lawson 1995).

But this phrase appears to refer to a more limited geographic area. After reaching the junction of the North Platte and South Platte on 22 June 1820, the expedition continued west along the north side of the North Platte River for a few miles then crossed the river heading southwest, making camp on the north side of the South Platte River. In their reconstruction of the route and itinerary of the Long Expedition, Goodman and Lawson (1995, p. 15) place the location of the camp of June 22 at 6–7 miles (10–12 km) west of the city of North Platte, which would be just to the east of the present-day community of Hershey, Nebraska.

On the morning of June 23, the party traveled about two miles (3.3 km) upstream then crossed to the south side of the South Platte. The crossing would have been in the vicinity of Hershey. James (1823, p. 468) states that the party "had no sooner crossed the [South] Platte when our attention was arrested by the beautiful white primrose (*Oenothera pinnatifida*. N.)" (= *O. coronopifolia* Torr. & A. Gray). In a footnote to his discussion of the *Oenothera*, James lists several other species that were collected "about the forks of the Platte."

Thus, it appears that the area referred to by James as "about the forks of the Platte" is tied to the locality of this crossing of the South Platte River in present-day Lincoln County, Nebraska on 23 June 1820. The type of *D. cylindriceps* was likely collected along the river somewhere between the towns of Hershey and Sutherland (ca. 12 km to the west), the latter being the vicinity of the expedition's camp of June 23 (Goodman & Lawson 1995, p. 16). This conclusion is supported by a collection of *D. cylindriceps* made on 05 August 1989 (*D. Sutherland 6802 with S. Rolfsmeier* at NEB, NY) along the South Platte River just south of Hershey.

Historical Accounts

Armed with knowledge of the nomenclatural history of *D. cylindriceps*, the early floristic and ecological literature of the Great Plains was searched for references to this species. The following is a summary of notable findings.

Dalea cylindriceps was encountered by many of the early botanical collectors traveling across the central Great Plains in the 1800s. The list includes Edwin James in 1820 (Torrey 1827), Augustus Fendler in 1846 (Gray 1848), Ferdinand Hayden in 1857 (Engelmann 1862), and Elihu Hall and J.P. Harbour (with Charles C. Parry) in 1862 (Gray 1863).

Where relative abundance is indicated, *D. cylindriceps* was typically classified as rare, infrequent, localized, etc. (Hitchcock 1896; Pound & Clements 1900; Ramaley 1939; Rogers 1953). This is in spite of fact that the species is a noticeable object in the landscape when present, as reflected in the comments of Pound and Clements (1900) in *The Phytogeography of Nebraska*, where they described *D. cylindriceps* (as *K. compacta*) as

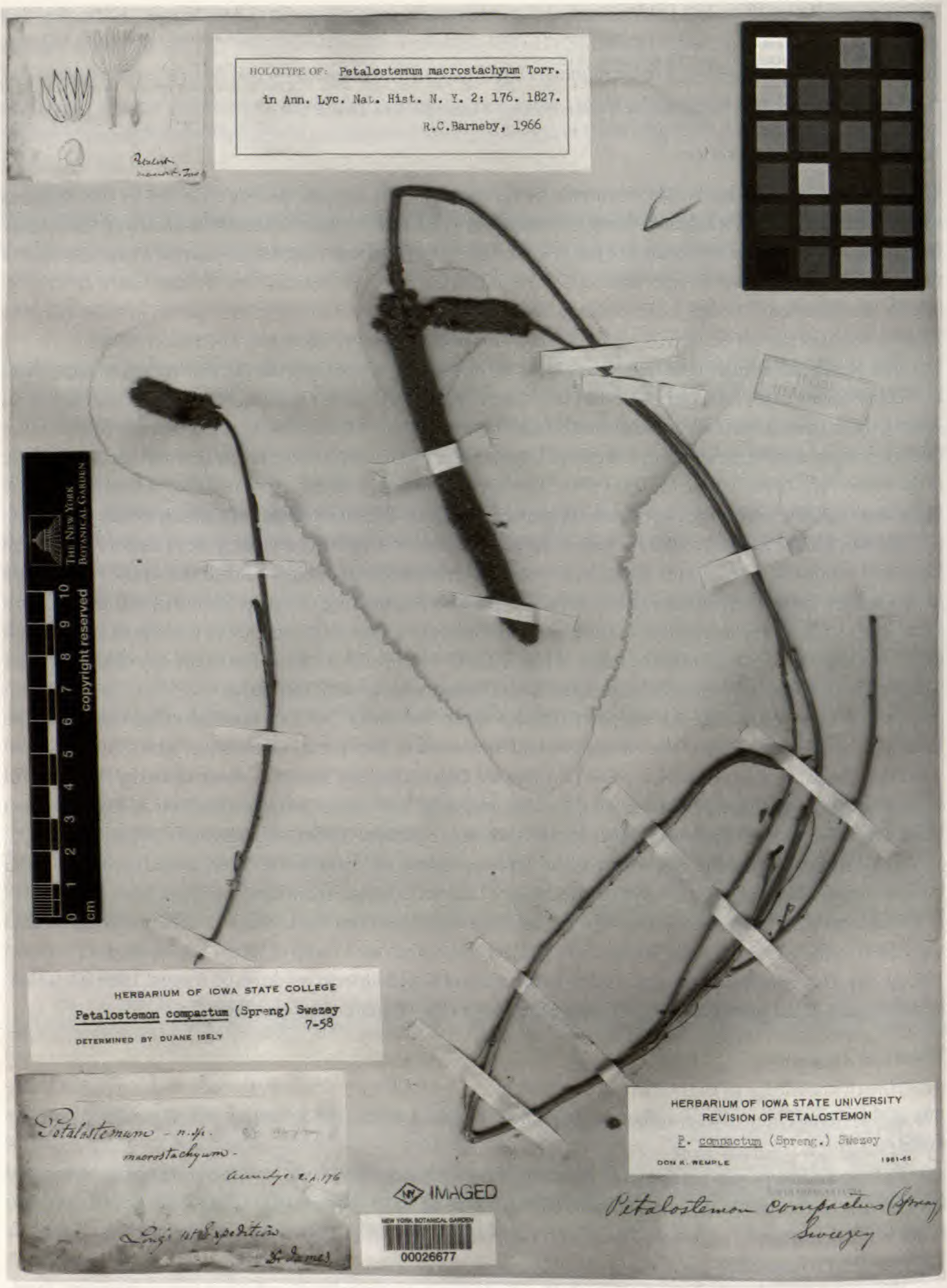

Fig. 3. Holotype of *Dalea cylindriceps* Barneby; *E. James s.n.* (holotype, NY). Digital image courtesy of the C.V. Starr Virtual Herbarium of the New York Botanical Garden.

"the most remarkable species of this genus in our flora. Its stems, which are densely leafy, are often a meter high and are very conspicuous on account of the long (a decimeter) nodding spikes of white or yellowish flowers."

Dalea cylindriceps may have been more abundant prior to settlement and agricultural development within its range. Eastwood (1893) included "*Petalostemon macrostachyus* Torr." in *A Popular Flora of Denver, Colorado*, her book aimed at "students" and "beginners" and therefore focused on the showier or more common elements of the flora. Eastwood stated the species occurred in "North Denver." There are a number of *D. cylindriceps* herbarium specimens collected in the late 1800s from what is today the Denver metropolitan area northward toward Fort Collins, but the native vegetation of this area has been largely displaced by suburban and ex-urban development.

The following references provide early accounts of the ecological associations of *D. cylindriceps*:

Colorado: "Sand Prairie" (Ramaley 1939, p. 14 as *P. compactus*). In his ecological study of the sandhill vegetation of northeastern Colorado, Ramaley recognized four plant communities occurring in upland sandy soils (Loose Sand and Blow-out; Sand-hills-Mixed; Sand-Sage; Sand Prairie); he listed *P. compactus* only under Sand Prairie, where he placed it on the list of "Other species," indicating relative infrequency.

Kansas: "Prairie" (Gray 1848, p. 33 as *P. macrostachyum*). Gray enumerated plants collected by Augustus Fendler in the vicinity of Santa Fe, New Mexico, which he reached in 1846 after traveling from St. Louis along the Santa Fe Trail. Gray reported the locality of the collection as "18 miles west of Lower Springs, Cimarron [River]." Lower Spring (also called Wagon Bed Spring) was a site along the Cimarron Cutoff of the Santa Fe Trail located on the Cimarron River in what is today Grant County, Kansas. A location along the trail 18 miles west of Lower Spring would be in present-day Morton County, Kansas in the vicinity of the Cimarron National Grasslands, where a number of recent collections of *D. cylindriceps* have been made in sandhill habitat.

Kansas: "Ulysses, Grant County…on sandy knolls along the South Fork of the Cimarron [River]. Rare." (Hitchcock 1896, p. 543 as *K. compacta*). Hitchcock reported on the plants collected by C.H. Thompson in southwestern Kansas in 1893.

Nebraska: "Sand hills along the Loup fork and Niobrara [rivers]" (Engelmann 1862, p. 189 as *P. macrostachyium* [sic]). Engelmann enumerated plants collected by Ferdinand Hayden in the Elkhorn, Loup, Platte, and Niobrara river valleys of present-day Nebraska during an expedition led by Lieutenant G.K. Warren of the U.S. Topographical Engineers in 1857.

Nebraska: "Localized in the sand-hills of Scotts Bluff county (sic)" (Pound & Clements 1900, p. 250 as *K. compacta*). Pound and Clements likely based their account of this species on herbarium material collected by P.A. Rydberg (*Rydberg 61*; NEB 177085, 177088; NY 1259216, 1259217) on 04 August 1891. Rydberg identified his number *61* as "Petalostemon macrostachyus Torr." in his journal (manuscript at NEB), noting the locality as "On the sandhills north of the Platte River, Scotts Bluff Co."

Such early references, as well as those found in more recent literature (Hazlett 2004; Kaul et al. 2011; Kuhn et al. 2011; Neid et al. 2007; Reif et al. 2009; Rolfsmeier & Steinauer 2010; Sutherland & Rolfsmeier 1989), indicate a strong association of *D. cylindriceps* with sandy habitat. Eolian sand sheets and sand dunes are common landforms in the western Great Plains, notably in Nebraska, Colorado, Kansas, Oklahoma, New Mexico, and Texas (Muhs & Holliday 1995). At present, these dune fields are mostly stabilized by vegetation.

Review of Great Plains floristic and ecological literature coupled with examination of herbarium specimens and the author's initial field survey, indicate that *D. cylindriceps* is frequently associated with plant communities in which the shrub sand sagebrush (*Artemisia filifolia*) is a dominant or distinctive element. Occurrences of *D. cylindriceps* in southwest Nebraska, eastern Colorado (Fig. 4), and southwest Kansas are associated with steppe communities comprised of a sparse to moderately dense layer of *A. filifolia* interspersed with tall or mid-height grasses, the component grass species varying with geography, precipitation, soil texture, etc. (Kuchler 1974, Lauver et al. 1999; Neid et al. 2007; Ramaley 1939; Rolfsmeier & Steinauer 2010). Frequently referred to as "sandsage prairie," these sometimes extensive communities occur on sands and loamy sands associated with eolian dune systems.

Fig. 4. *Dalea cylindriceps* in *Artemisia filifolia* community, Cheyenne County, Colorado. Photo James Locklear.

Dalea cylindriceps has been collected (to a lesser extent) in other sandy-gravelly habitat, notably the alluvial deposits of streams and colluvium derived from sandstone outcrops and escarpments. The mostly herbaceous plant communities that develop in such habitat occur as small patches or bands of vegetation in the landscape

The association of *D. cylindriceps* with sandsage prairie could be a factor in the apparent decline of this species. Throughout the Great Plains, extensive tracts of sandsage prairie have either been converted to irrigated cropland, degraded by intensive grazing, or subject to extensive alteration to enhance grazing potential, primarily through the use of herbicides to decrease the density of *A. filifolia* in favor of grasses (Farrar 1993a; Sexson 1983).

Future Research

University of Kansas botanist Ronald L. McGregor (1986) asserted nearly 30 years ago that *D. cylindriceps* "needs more careful study," and his statement holds true yet today. Additional research is needed to more fully assess the conservation status of *D. cylindriceps*. Survey of historical occurrences throughout the range of the species is needed to determine the number of existing occurrences and to develop a more detailed ecological profile that includes habitat requirements, edaphic factors, disturbance factors, associated species, etc. As a more precise understanding of the ecology of *D. cylindriceps* is gained, field workers can be more strategic in identifying potential habitat to search for additional occurrences.

Research into the life history traits (phenology, reproductive ecology, etc.) of *D. cylindriceps* is needed to determine how these shape demography and population trends. This species appears to be a short-lived or even

monocarpic herbaceous perennial (Barneby 1977; Kaul et al. 2011). McGregor (1986) noted that on dunes and areas of loose sand, *D. cylindriceps* "sometimes flowers the first year and frequently expires at the end of the second or third season," yet is often a longer-lived perennial in more stable sandy areas.

Many plant species associated with sandy habitat are specialized to a particular ecological niche or stage of recovery related to natural disturbance, and research is needed to determine if such is the case for *D. cylindriceps*. Sandsage prairie is a naturally dynamic plant community, with species composition, patterns of vegetation, and percent canopy cover changing over time in response to fluctuations in precipitation (Collins et al. 1987; Farrar 1993b; Kelso et al. 2007; Ramaley 1939; Rondeau 2003, 2013). Such recurring natural disturbance could result in fluctuations in the presence and abundance of *D. cylindriceps* over time.

Monitoring studies of existing populations of *D. cylindriceps* are needed to answer these and other questions of life history, demography, and population trends. Further study of *D. cylindriceps* would be of value not only for the conservation and management of this species, but also holds promise for a better understanding of the ecology and dynamics of sandsage prairie, a plant community that is of conservation concern throughout most of its distribution in the western Great Plains (NatureServe 2013). Given its close association, *D. cylindriceps* could serve as an indicator species of high quality occurrences of sandsage prairie and of habitat integrity and health.

A Common Name for *Dalea cylindriceps* Barneby

The misleading common name "Andean prairie-clover" has been applied to *D. cylindriceps* and is currently in use by NatureServe (2013) and other databases listing plants of conservation concern. *Dalea cylindriceps* is not a plant of the Andes, and this common name may have had its origin in the binomial *D. macrostachya* Moric., which is similar to *P. macrostachyum* Torr., the first validly published name for what is now recognized as *D. cylindriceps*. *Dalea macrostachya* is a replaced synonym for *D. coerulea* (L.f.) Shinz & Thell. var. *longispicata* (Ulbr.) Barneby, which occurs in the Andean region of South America (Barneby 1977).

Several other common names have been adopted for *D. cylindriceps* that point to the dense, elongate spike-like inflorescence which is a distinctive morphological feature of this species. These include "dense-flowered prairie clover" (Britton & Brown 1897; Saunders 1899), "massive spike prairie-clover" (GPFA 1986), and "large-spike prairie-clover" (Kaul et al. 2011; Stubbendieck & Conard 1989). The latter two names reflect Barneby's (1977) etymology of *cylindriceps*: "of the massive spike."

The common name "sandsage prairie-clover" is proposed here based on the close association of *D. cylindriceps* with sandsage prairie and similar plant communities in which sand sagebrush (*A. filifolia*) is a dominant or distinctive element.

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POTENTIAL DISTRIBUTION MODELING OF *PENSTEMON OKLAHOMENSIS* (PLANTAGINACEAE)

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ABSTRACT

Penstemon oklahomensis is an endemic to the southern plains region that occurs in Oklahoma and one location in Texas. As an aid to conservation of this species, we used a species distribution model to map the possible extent of *Penstemon oklahomensis* in Oklahoma. Location data were derived from specimens in the Oklahoma Vascular Plants Database and occurrence records maintained by the Oklahoma Natural Heritage Inventory. We then modeled the potential distribution of *P. oklahomensis* with MaxEnt, a technique suitable for presence-only data. Resulting maps were used to field validate the model and determine if a gap in the southwestern portion of its range was a sampling artifact, resulting in two new first county records for the species.

RESUMEN

Penstemon oklahomensis es un endemismo del sur de la región de las llanuras que se da en Oklahoma y una localidad de Texas. Como ayuda para la conservación de esta especie, usamos un modelo de distribución de especies para mapear la posible extensión de *Penstemon oklahomensis* en Oklahoma. La posición de los datos se derivó de los especimenes existentes en la Oklahoma Vascular Plants Database y citas de ocurrencia mantenidos por el Oklahoma Natural Heritage Inventory. Luego modelamos la distribución potencial de *P. oklahomensis* con MaxEnt, una técnica apropiada para datos de solo presencia. Los mapas resultantes se usaron en el campo para validar el modelo y determinar si un hueco en la porción suroeste de su rango era un artefacto de muestreo, resultando en dos primeras citas de la especie para el condado.

INTRODUCTION

Advances in geospatial technologies and increased accessibility of species collection data have placed the mapping of species' geographical ranges at the forefront of biogeographic research and conservation planning (Guisan & Thuiller 2005; Franklin 2009; Peterson et al. 2011). Location information from natural history collections has become prevalent online in large databases (Elith et al. 2006; Newbold 2010; Peterson et al. 2011), allowing for easier mapping of a species' current and historic localities (Graham et al. 2004; Newbold 2010; Peterson et al. 2011). Likewise, efforts to collect precise location data, with the assistance of GPS, also have improved in recent years. Models of species distribution have provided insight into, generated hypotheses about a species' ecology, and aided in the location of new populations (Austin 2002; Hirzel et al. 2002; Guisan & Thuiller 2005; Franklin 2009; Lobo et al. 2010; Newbold 2010; Naimi et al. 2011).

The objective of this study was to develop a predictive range map for the distribution of *Penstemon oklahomensis* Pennell (Plantaginaceae). The genus *Penstemon* contains approximately 237 species and is one of the largest plant genera in North America (Freeman In prep; Lindgren & Wilde 2003; Nold 1999). Although *P. oklahomensis* is one of 13 species of *Penstemon* that occur in Oklahoma, it is a unique regional endemic to the southern plains region. It has been documented in 24 Oklahoma counties (Hoagland et al. 2012). In fact, all known populations were restricted to central Oklahoma until the recent discovery of a population in North Texas (Mink et al. 2010). *Penstemon oklahomensis* is a native perennial that flowers from April to mid-June and is one of only four species of *Penstemon* with a closed throat floral morphology. Of these four species, *P. oklahomensis* has the most restricted distribution (Clements et al. 1998; Pennell 1935). *Penstemon oklahomensis* most

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frequently occurs in remnant Tallgrass prairie, but has also been found in other prairie types as well as open woodlands (Hoagland et al. 2012). The Oklahoma Natural Heritage Inventory tracks *P. oklahomensis* as a state rare species (S1). At the global level, it is ranked as a G3 (either very rare and local throughout its range or found locally, even abundantly at some of its locations) and S3 (rare and local distributed within Oklahoma) (Oklahoma Natural Heritage Inventory 2012).

This project is also intended to contribute to our understanding of the ecology of *P. oklahomensis*, for which there are few published studies. A recent study of *Penstemon oklahomensis* habitat, indicated the soils where populations occur ranged from sandy loam to loam with a pH range of 5.5–7.6 and relatively low nitrogen, phosphorous, and potassium levels. The same study also found *P. oklahomensis* populations to persist in grassy roadside areas that are disturbed through various mowing regimes (Messick & Hoagland 2012).

Study Area

The study area encompasses the state of Oklahoma, although populations of *P. oklahomensis* have not been documented in western parts of the state, congeners occur in all regions. We took this approach to determine the regional extent of potential habitat. The long axis of Oklahoma has an east-west orientation that spans 6.5 degrees of longitude (from 94°30'W to 103°W) and 3.25 degrees of latitude (33°30'N to 37°N). Along this axis are two important environment gradients; elevation and precipitation. Elevation decreases from 1,516 m in the northwest, at Black Mesa, to 110 m in the southeast, where the Little River exits the state into Arkansas. Average annual precipitation also follows a northwest to southeast gradient, with the lowest values in the northwest (43 cm) and the highest in the southeast (142 cm). There is a weak south-north gradient in temperature. The length of the growing season ranges from 225-230 days along the Red River and 175 days on the border with Kansas. Average annual temperature increases roughly from 13.3°C in the northwest to 16.7°C in the southeast (Johnson & Duchon 1995).

METHODS

The successful analysis of species distribution relies upon the compilation of numerous layers of geospatial data. The primary dataset for such analyses is location data, preferably in a geographic coordinates, derived from specimen data. Location data for *P. oklahomensis* was compiled from specimen voucher data from the Oklahoma Vascular Plants Database (OVPD) (Hoagland et al. 2012), the Oklahoma Natural Heritage Inventory (ONHI) (Oklahoma Natural Heritage Inventory 2012), and other sources (Freeman 1981). As noted earlier, a population of *P. oklahomensis* has been reported from northeastern Texas, which is 51.5 km from the nearest Oklahoma population (Mink et al. 2010), and was excluded from this analysis due to a lack of detailed information on the population in question and access to geospatial data for Texas. We recognize the importance of this population, however, and encourage the exploration of intervening areas between the Texas and Oklahoma populations

Once extracted, location data were compiled into a geodatabase and edited to remove duplicate records. Duplicate records were found primarily in the OVPD and are a byproduct of specimen exchanges between in-state institutions. Duplicate records also existed between the OVPD and the ONHI database. Next, geographic precision of the records was assessed. Geographical coordinates were not provided on the majority of herbarium vouchers predating 2000, but either driving directions and/or land survey references (e.g., township, range, and section) were recorded. Thus it was necessary to manually assign geographical coordinates. Specimens that listed only the county or equally vague geographic reference (e.g., Indian Territory) were excluded from analysis. The resulting dataset for analysis consisted of 142 location points (Fig. 1).

When mapping species distributions, it is important to examine both the extent of occurrence (EOO) and area of occupancy (AOO). The EOO represents the entire area in which a species has been found, including gaps between populations, and is bounded by the outermost occurrences of a species. The gaps between populations may simply represent inadequate sampling effort or are possibly areas of unsuitable habitat. The EOO for a species can be mapped using the convex hull operation. The resulting map is a more accurate depiction of a species distribution than one created using rectangles or circles encompassing all known locations of a spe-

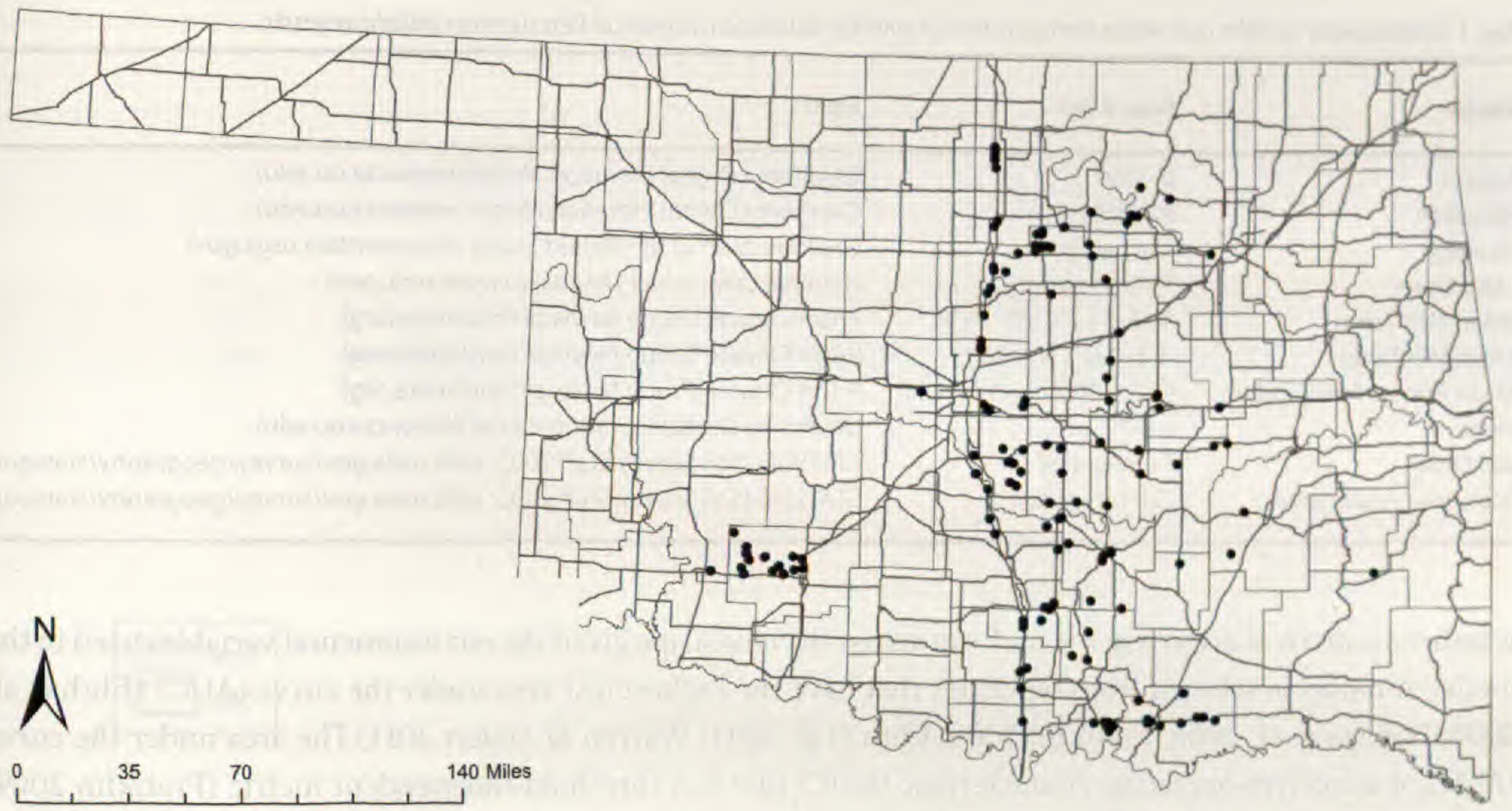

Fig. 1. Point distribution map of *Penstemon oklahomensis* in Oklahoma, includes interstate and state highways before modeling.

cies (Podani 2009). The AOO is the area where the target species is actually found and is either equal to or smaller than the EOO. The AOO does not include gaps between populations. Removing gaps or discontinuities in an EOO results in the AOO for a species (Gaston & Fuller 2009).

The EOO map of *P. oklahomensis* was generated using the Convex Hull module of ArcGIS 10 using the species occurrence data layer. Upon inspection, the resulting map exhibited a significant gap in the species distribution between central and southwestern Oklahoma. Thus, we repeated the convex hull operation so that the southwestern Oklahoma collection points (n=15) were aggregated into a polygon separate from a larger central Oklahoma area polygon.

Maximum entropy (MaxEnt), the method most frequently used in species distribution modeling, was chosen for modeling the distribution of *P. oklahomensis*. (Franklin 2009; Naimi et al. 2011). MaxEnt was designed specifically for use with presence-only data, such as the *P. oklahomensis* dataset, and can analyze small sample sizes (< 100 samples) and overcome sampling bias (Franklin 2009).

MaxEnt analyzes species occurrence data in conjunction with a suite of environmental data to calculate an index of relative suitability for a species (Graham et al. 2008; Anderson & Gonzalez 2011; Elith et al. 2011). Environmental factors are independent variables and are referred to as covariate or predictor variables. The environmental variables used in this study were elevation, slope, aspect, land cover type, soil order, soil series, geology, mean minimum annual temperature, mean maximum annual temperature, and mean annual precipitation (Table 1). Slope and aspect were derived from a 30 m DEM using ArcGIS Spatial Analyst Toolbox and then clipped to the political boundaries of Oklahoma. All of the remaining environmental variables were acquired as vector data and were converted to raster format to match the extent and scale of the DEM.

MaxEnt attempts to derive a log-linear model that is dependent on the presence points and a set of selected randomly from the environmental data layers, referred to as background points, to estimate the probability of an occurrence or population in a locality. Should an actual species presence point be selected as a background point, then the environmental features are rescaled on a scale of 0–1, and an error boundary for the point is calculated. The error bounds are calculated from the environmental features rather than the presence points because the presence points are often biased (Elith et al. 2011).

Model evaluation

The output of MaxEnt is a probability of species occurrence based on the concept of maximum entropy or

Table 1. Environmental variables used within MaxEnt models for potential distribution mapping of *Penstemon oklahomensis*.

Variable	Range & Unit	Source
Aspect	0–359°	Oklahoma Digital Elevation Model (www.csa.ou.edu)
Elevation	87–806 m	Oklahoma Digital Elevation Model (www.csa.ou.edu)
Geology	156 categories	Geologic Map of the United States (www.mrdata.usgs.gov)
Land Cover	15 categories	National Land Cover Database (www.mrlc.gov)
Mean Max Temp	30.5–37.2°C (87–99°F)	Prism Climate Group (www.prismclimate.org)
Mean Min Temp	-8.3–0.6°C (17–33°F)	Prism Climate Group (www.prismclimate.org)
Mean Annual Precipitation	43.2–180.3 cm (17–71 in)	Prism Climate Group (www.prismclimate.org)
Slope	0–57°	Oklahoma Digital Elevation Model (www.csa.ou.edu)
Soil Order	7 categories	STATSGO (Soil Survey Staff 2005; soils.usda.gov/survey/geography/statsgo)
Soil Series Association	228 categories	STATSGO (Soil Survey Staff 2005; soils.usda.gov/survey/geography/statsgo)

whether a pattern of occurrence is uniform across the landscape given the environmental variables used in the model. A model is selected from replicates that have the highest test area under the curve (AUC) (Elith et al. 2006; Phillips et al. 2006; Franklin 2009; Elith et al. 2011; Warren & Seifert 2011).The area under the curve (AUC) of a receiver-operating characteristic (ROC) plot is a threshold-independent metric (Franklin 2009; Jimenez-Valverde 2012). A ROC plot graphs "the false-positive error rate on the x-axis (1 - Specificity) versus the true positive rate on the y-axis (Sensitivity) based on each possible value of threshold probability" (Franklin 2009). The AUC is calculated from the resulting curve and can range from 0.5 to 1.0. The value 0.5 represents random predictions while values above 0.5 represent "performance better than random" (Franklin 2009; Jimenez-Valverde 2012). An AUC value between 0.5 and 0.7 indicates low or poor performance, between 0.7 and 0.9 indicates moderate performance, and values greater than 0.9 indicate high performance (Swets 1988; Franklin 2009).

We used MaxEnt version 3.3.3e modeling software (www.cs.princeton.edu/~schapire/maxent) to model the potential distribution of *P. oklahomensis*. The analysis was run with 0%, 10%, 20%, 30%, 40%, and 50% of the *P. oklahomensis* point locations withheld for testing the model. Collectively these model runs were called Model Set A. For each percentage category for which points were withheld, 15 replicates were generated. Response curves, jackknife of variable importance, and maps of predicted distributions were also generated. The jackknife of variable importance identifies the individual variable(s) that were most important in predicting the species' distribution (Elith et al. 2011). In order to evaluate the potential outlier affect of the *P. oklahomensis* occurrence in eastern Oklahoma, the analysis was conducted a second time and the resulting models were referred to as Model Set B.

MaxEnt created grids for the average, minimum, maximum, median, and standard deviation of the predictions for each percentage category withheld run based on the test AUC value. The average prediction grids were converted to raster files and the resulting prediction AUC values were then compared. Based on the prediction maps, the gap in the distribution between the southwestern populations and the central populations was surveyed for *P. oklahomensis* populations. This area included three counties; Grady County, Stephens County, and Jefferson County. If a *P. oklahomensis* population was discovered, voucher specimen was collected and deposited at the Robert Bebb Herbarium (OKL) at the University of Oklahoma, Norman, OK.

RESULTS AND DISCUSSION

The county-level map of the 142 *Penstemon oklahomensis* (Fig. 1) location points revealed that the majority of collection points were both in central Oklahoma and clustered near interstate or state highways. To verify this pattern, we calculated Moran's I (I), which proved a significant pattern ($I = 0.371$, z score = 3.385, $p = 0.001$). Also, the AOO for this species was much smaller in area than the EOO and as noted earlier, there were two noteworthy gaps in the EOO; the first in the southeast and a second in the southwest (Fig. 2). Since the gap in the southwest was more pronounced geographically and was represented by a greater number of occurrences

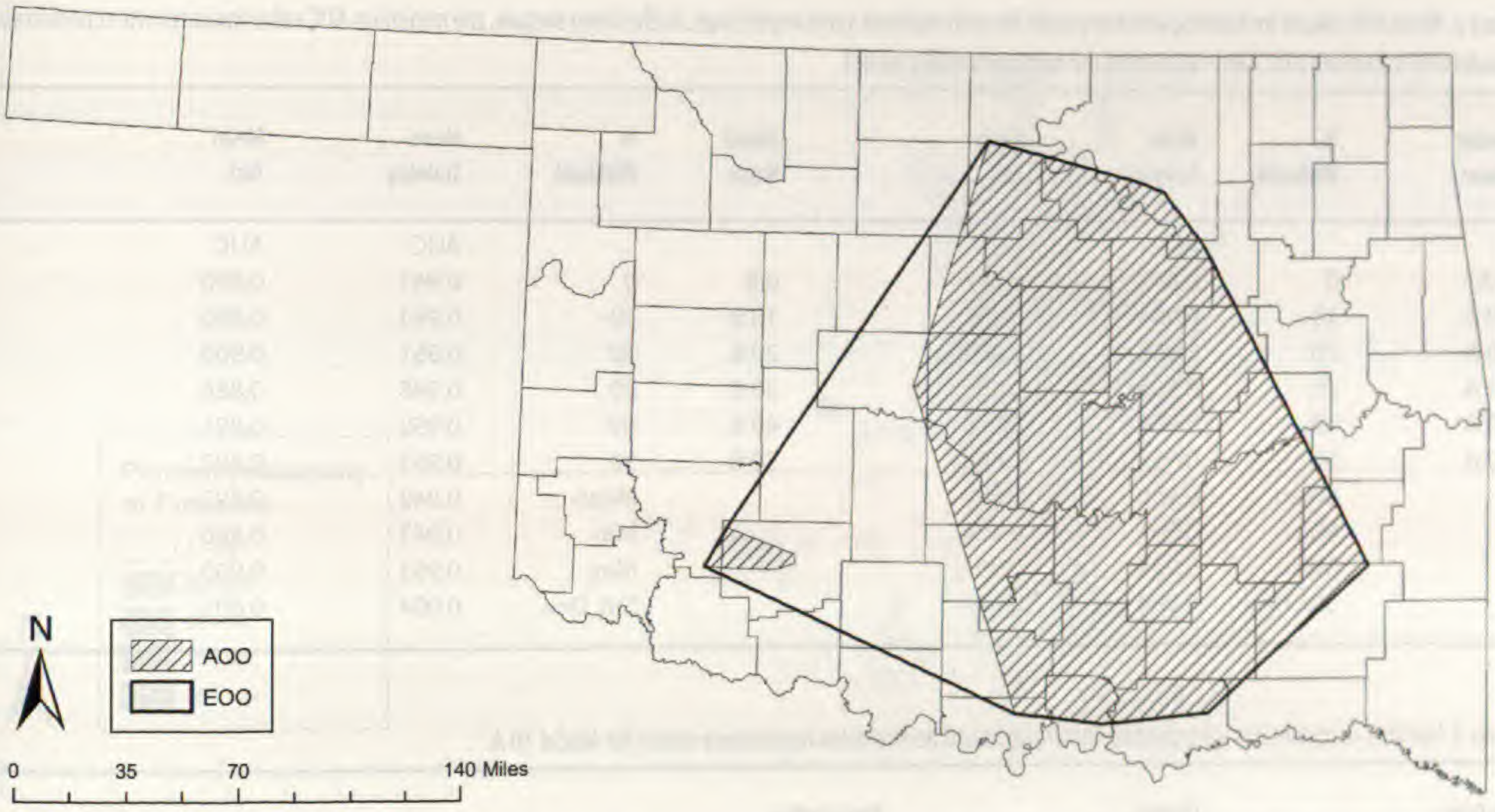

Fig. 2. Extent of occurrence (EOO) and area of occupancy (AOO) for *Penstemon oklahomensis* within Oklahoma before modeling.

(n=15) than the southeast (n=1), it became the focus of our analysis and groundtruthing. Our goal was to ascertain whether this was a true gap in distribution or a sampling artifact.

The training and test AUC values for both model sets are listed in Table 2. Model 40 A had the highest training AUC (0.954) while Model 10 A had the lowest training AUC (0.944). For the test data, Model 10 A had the highest AUC (0.907) and Model 50 A had the lowest AUC (0.889). From the test data used in Model 10 A, the jackknife of the environmental variables showed geology (25.6% contribution) and soil series association (20.6% contribution) to be the most important (Table 3). Model 50 B had the highest training AUC (0.953) and Model 0 B had the lowest training AUC (0.943). For the test data, Model 20 B had the highest AUC (0.900) and Model 30 B had the lowest AUC (0.886). The jackknife of environmental variables from the test data used in Model 20 B also showed geology (27.7% contribution) and soil series association (22.2% contribution) to be the most important (Table 4). Model 20 B (Fig. 3) was selected as the best predictive map for the potential distribution of *P. oklahomensis* within Oklahoma because of its AUC value even though the value is the cut-off value (0.900) between moderate and high performance according to Swets' scale (1988).

Groundtruthing

MaxEnt predicted greater than 25% probability of occurrence of *P. oklahomensis* populations in extreme northern Grady County and another in southern Grady County, a location within the southwestern distribution gap. The two predicted northern locations were surveyed, but one proved to be a wheat field and the other a grazed pasture. A new population (Fig. 4) of *P. oklahomensis* was located, however, at the southern location where the model predicted 25%–49% probability of occurrence. Another locality within the portion of Stephens County in the gap, with a greater than 25% probability of an occurrence was surveyed, but no populations were found. A predicted location in northern Stephens County, with less than a 25% probability of occurrence, did produce a new population (Fig. 4). Additional surveys of counties in the southwestern gap did not yield new populations of *P. oklahomensis*.

The point locations of the new populations were added to the overall point distribution map and the probability values extracted from the model. The Grady County population probability value was 0.21 and the value for the Stephens County population was 0.03. The two new location points were added to the same dataset used to produce Model Set B, and MaxEnt run again with the same settings to produce Model Set C. The AUC

Table 2. Mean AUC values for training and test points for each replicate set of models run. In the lower section, the minimum AUC value indicates worst performing model and maximum AUC value represents the best performing model.

Model Name	% Withheld	Mean Training	Mean Test	Model Name	% Withheld	Mean Training	Mean Test
		AUC	AUC			AUC	AUC
0 A	0	0.947	0.897	0 B	0	0.943	0.890
10 A	10	0.944	0.907	10 B	10	0.944	0.896
20 A	20	0.950	0.906	20 B	20	0.951	0.900
30 A	30	0.952	0.895	30 B	30	0.948	0.886
40 A	40	0.954	0.898	40 B	40	0.950	0.891
50 A	50	0.952	0.889	50 B	50	0.953	0.892
	Mean	0.950	0.899		Mean	0.948	0.892
	Min	0.944	0.889		Min	0.943	0.886
	Max	0.954	0.907		Max	0.953	0.900
	Std. Dev.	0.004	0.007		Std. Dev.	0.004	0.005

Table 3. Variable contributions with percent contribution and permutation importance values for Model 10 A.

Variable	Percent Contribution	Permutation Importance
Geology	25.6	17.7
Soil Series	20.6	13.9
Precipitation	19.7	7.6
Land Cover	13.2	8.6
Soil Order	5.4	6.5
Slope	4.9	5.3
Min Temp	4.8	15.9
Elevation	4.8	20.6
Aspect	0.5	0.8
Max Temp	0.4	3.0

Table 4. Variable contributions with percent contribution and permutation importance values for Model 20 B.

Variable	Percent Contribution	Permutation Importance
Geology	27.7	14.7
Soil Series	22.2	17.7
Land Cover	13.0	9.8
Precipitation	10.7	3.2
Soil Order	9.5	7.7
Elevation	5.6	13.4
Min Temp	5.3	20.0
Slope	5.1	10.2
Max Temp	0.5	2.8
Aspect	0.5	0.7

values of Model Set C are listed in Table 5. Adding the new location points to the dataset lowered the AUC values of all models into the moderate performance range, contrary to expectation.

CONCLUSION

Our objective was to glean a better understanding of factors controlling the distribution of *Penstemon oklahomensis* across its geographic range. Data for this effort was collected from Freeman (1981), OVPD (Hoagland et

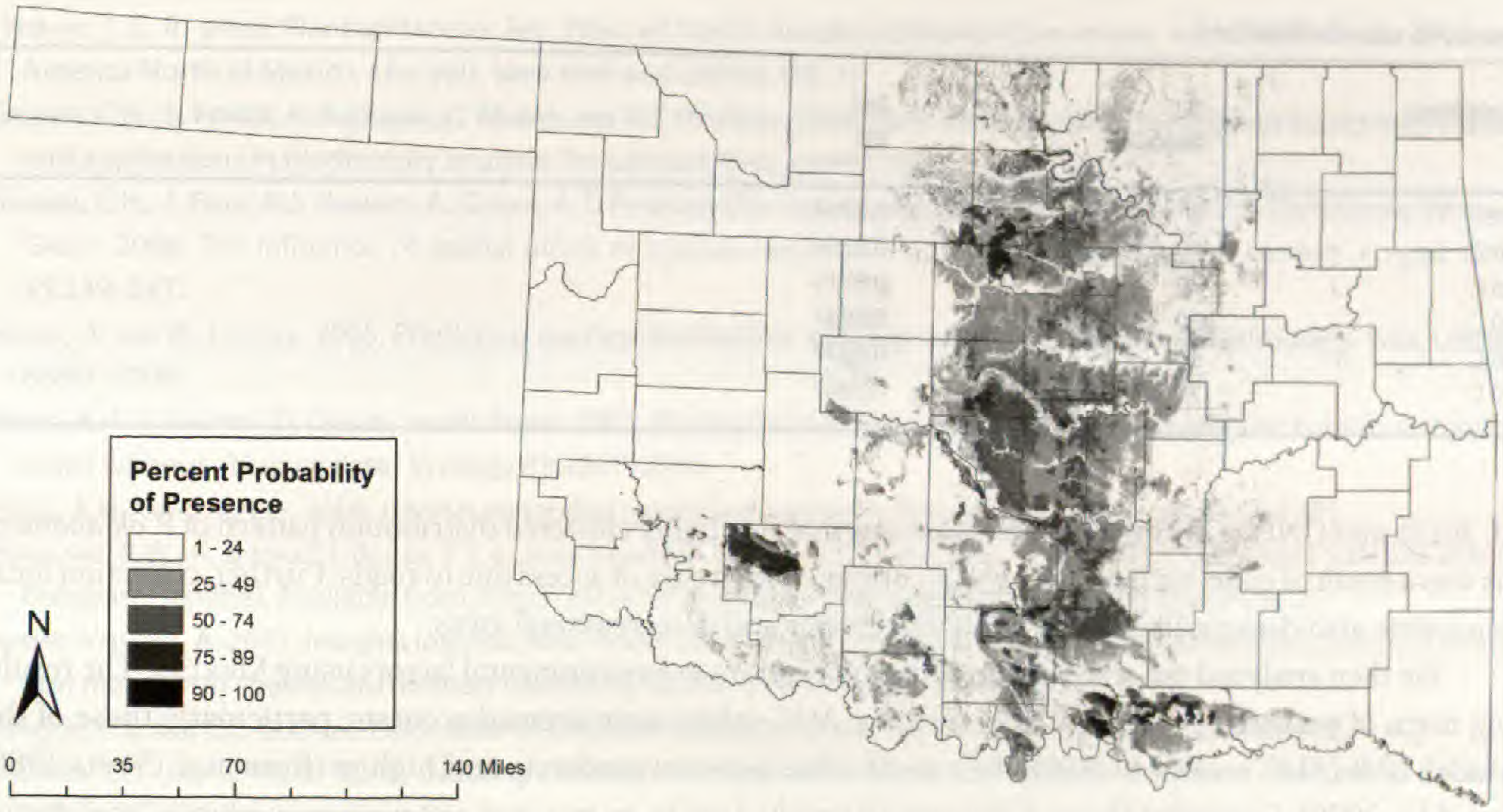

Fig. 3. Prediction map for *Penstemon oklahomensis* potential distribution within Oklahoma; Model 20 B.

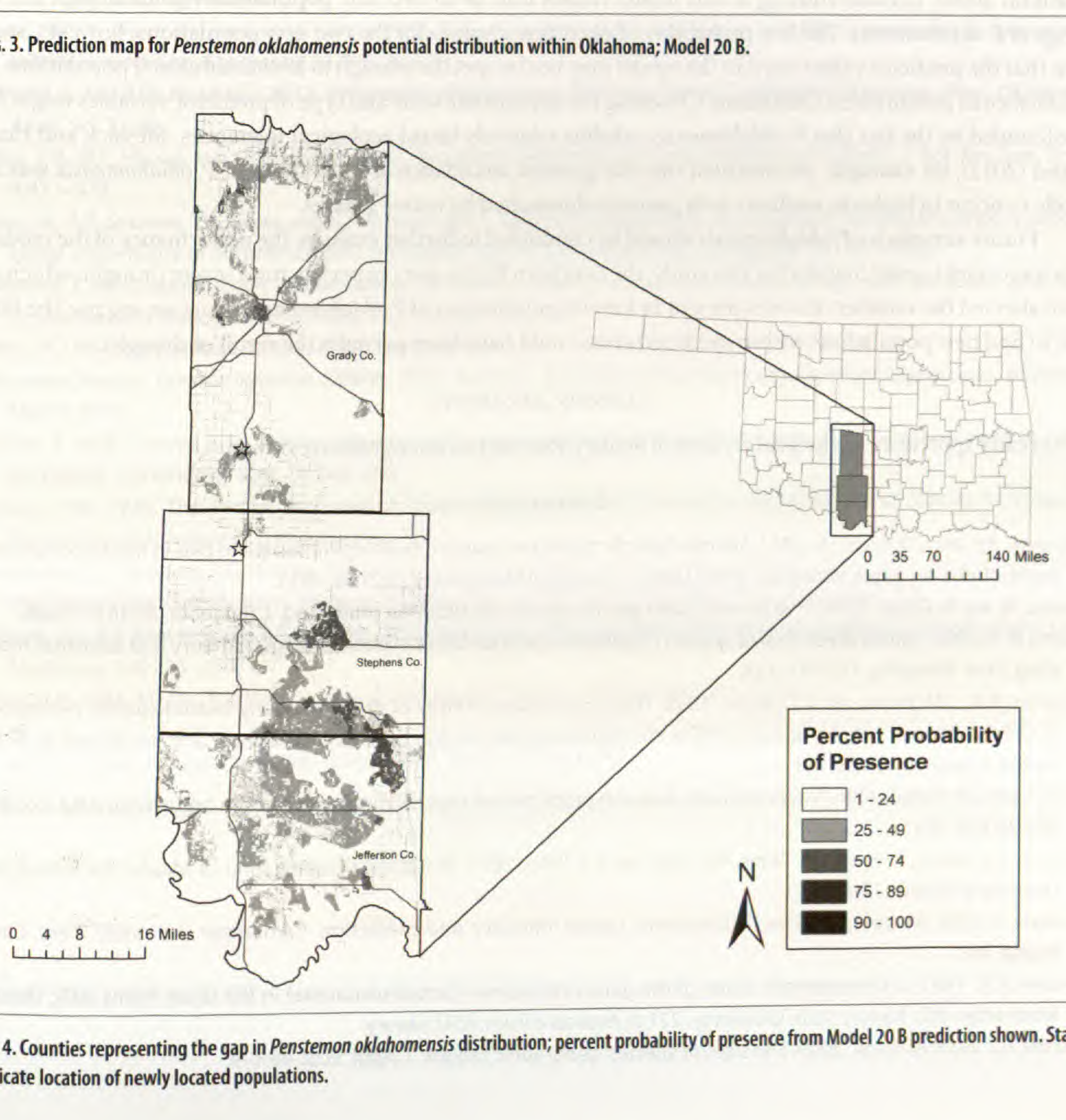

Fig. 4. Counties representing the gap in *Penstemon oklahomensis* distribution; percent probability of presence from Model 20 B prediction shown. Stars indicate location of newly located populations.

TABLE 5. AUC values for Model Set C.

Model Name	% Withheld	Test AUC
0 C	0	0.8944
10 C	10	0.8859
20 C	20	0.8819
30 C	30	0.8837
40 C	40	0.8877
50 C	50	0.8851

al. 2012), and ONHI. Our initial observation was that the highly clustered distribution pattern of *P. oklahomensis* was a result of collector bias, which was correlated with ease of access due to roads. Further, collection locations were also clustered near cities with universities and in recreational areas.

We then analyzed the relationship of the distribution to environmental factors using MaxEnt. The resulting maps of potential probability of occurrence AUC values were deemed accurate, particularly those of the Model 20 B (AUC = value of 0.90), the cut-off value between moderate and high performance (Swets 1988; Franklin 2009). Groundtruthing of this model results lead us to two new populations within a "gap" in the range of *P. oklahomensis*. The low probability of occurrence values for the two new populations, however, suggest that the predictor values used in the model may not be specific enough to locate additional populations *P. oklahomensis* in southwest Oklahoma. Choosing the appropriate scale and type of predictor variables might be confounded by the fact that *P. oklahomensis* exhibits relatively broad ecological tolerances. Messick and Hoagland (2012), for example, documented that the greatest abundance of individuals of *P. oklahomensis* was as likely to occur in highway medians as in pastures dominated by native grasses.

Future surveys for *P. oklahomensis* should be conducted to further evaluate the performance of the model. It is important to note that during this study, the Southern Plains were experiencing a severe drought, which in turn affected the number of stems present in known populations of *P. oklahomensis*. Thus we suggest the failure to find new populations within predicted areas could have been partially the result of drought.

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NEW BOOK ANNOUNCEMENT

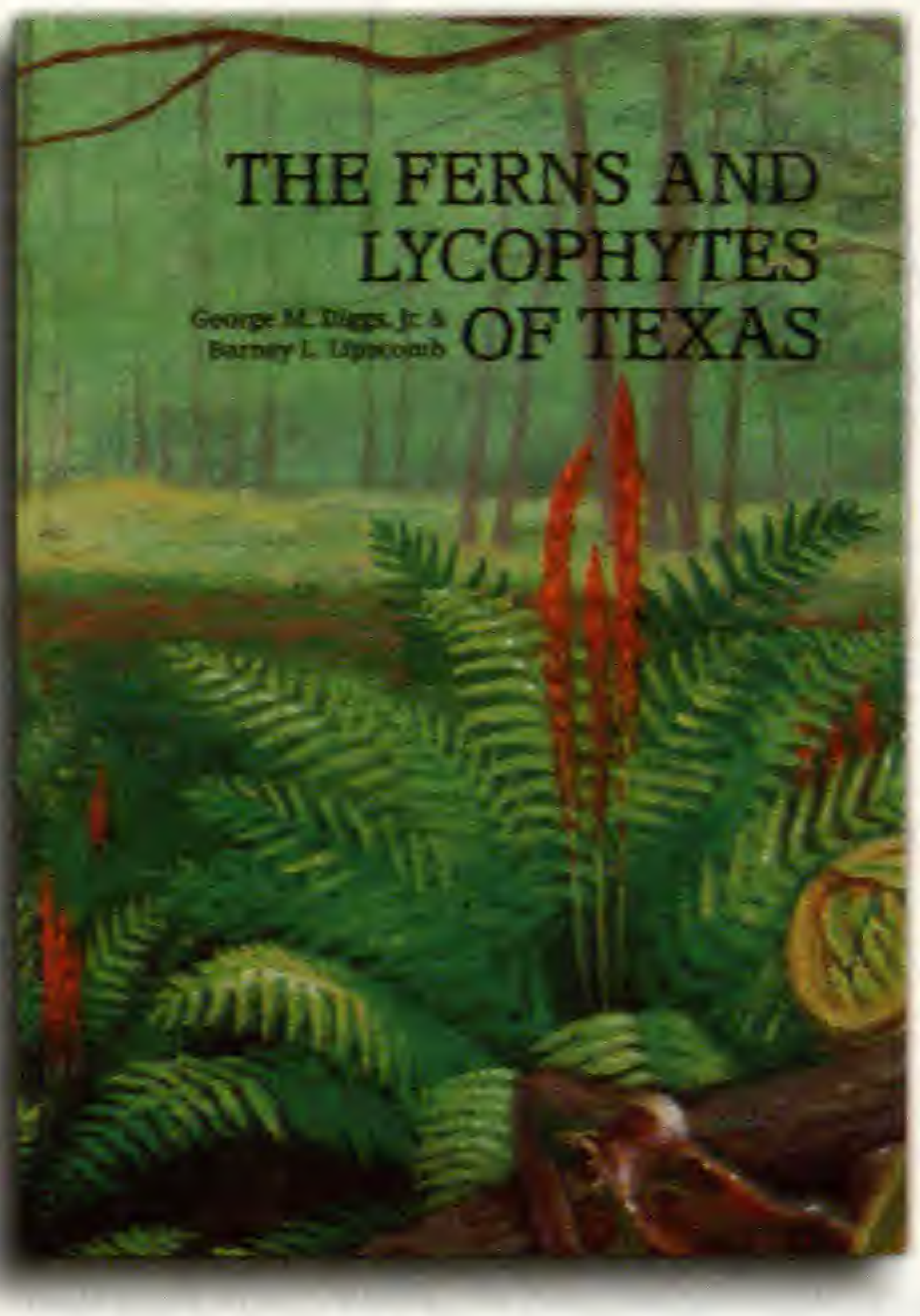
George M. Diggs, Jr. and Barney L. Lipscomb. February 2013. **The Ferns and Lycophytes of Texas.** (ISBN-13: 978-1-889878-37-9, flexbound). Botanical Research Institute of Texas Press, 1700 University Drive, Fort Worth, Texas 76107, U.S.A. (**Orders:** www.britpress.org, orders@brit.org, 1-817-332-4441 x 264). $29.95, 392 pp., color photos, distribution maps, 7" × 10".

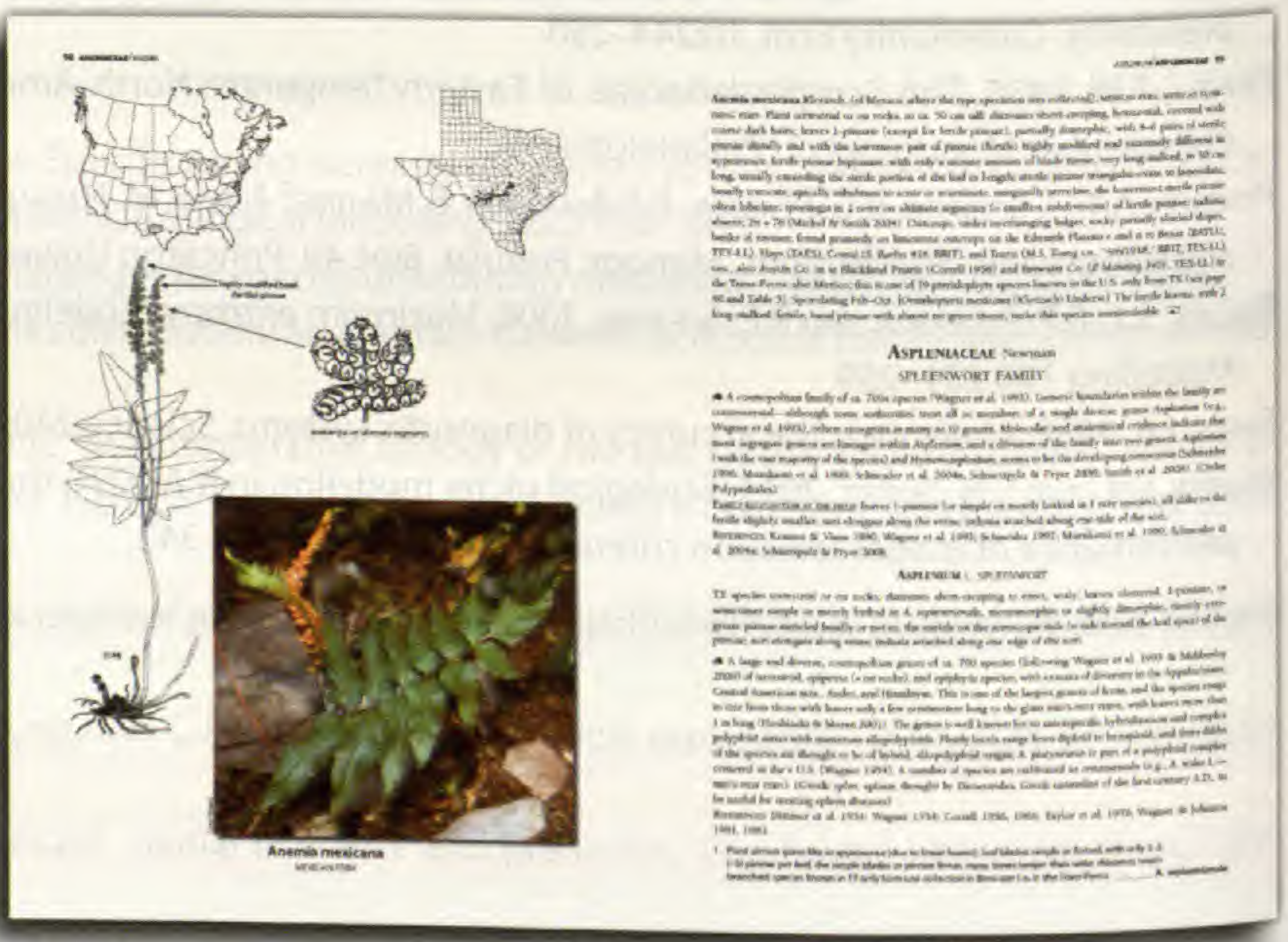
From the publisher:

Texas has a surprising number of native ferns and lycophytes—127 in all, the most of any state in the continental U.S.A. This is particularly unexpected given that most people associate ferns and related plants with humid, even tropical, conditions, just the opposite of much of Texas. This book explains why and looks at the fascinating world of Texas ferns, ranging from the swamp forests of far East Texas, to the hidden canyons of the Edwards Plateau, and even to the high mountain "sky islands" of such places as Big Bend National Park. Each species has an illustration page with a color photo, a line drawing, and detailed maps. Be ready to be surprised by this special group of Texas plants.

George Diggs is a botanist and evolutionary biologist who has taught for more than 30 years at Austin College in Sherman, Texas. His research interests include the flora of Texas, evolution as it relates to human health, biogeography, and the systematics of the Ericaceae (the blueberry family). He has co-authored four books and more than 30 scientific articles, and has given hundreds of public lectures. In his research he has traveled to all seven continents. He is the Donald MacGregor Chair of Natural Science at Austin College and a Research Associate at the Botanical Research Institute of Texas.

Barney Lipscomb is a botanist, editor, public speaker, and researcher who began his career at Southern Methodist University in Dallas, Texas, in 1975 and is now the Leonhardt Chair of Texas Botany at the Botanical Research Institute of Texas, Fort Worth. His research interests include the flora of Texas, taxonomy of the Cyperaceae (the sedge family), poisonous plants, the application of botany to forensic science, and natural history art as it relates to science. He has co-authored three books, contributed more than 30 scientific articles, and has given more than 700 public lectures to advance the public's understanding of botany.





RANGE EXPANSION OF *PANICUM REPENS* (POACEAE) INTO CENTRAL TEXAS (U.S.A.) MAY THREATEN ENDANGERED SPECIES

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ABSTRACT

The westward range extension of the highly invasive aquatic grass, *Panicum repens* (torpedograss), in the San Marcos River, Hays County, Texas and its implications to listed species and critical habitat are reported. This range extension represents an increase of ca. 275 km linear distance west from Trinity County in eastern Texas Pineywoods to Hays County on the eastern edge of the Edwards Plateau and western margin of the Blackland Prairie ecoregions. It is likely that *P. repens* is not a recent, within the last 3–5 years, introduction into the San Marcos River because an area greater than 0.4 ha was observed on November 9, 2012, just below Cumming's Dam with smaller and scattered patches located downstream. The species ability to reproduce asexually and invade new areas makes it a severe threat to threatened and endangered species and their critical habitat within the upper San Marcos River.

RESUMEN

La extensión hacia el oeste de la hierba acuática muy invasiva, *Panicum repens* (torpedograss), en el Río San Marcos en el Condado Hays, Texas y sus implicaciones con otras especies son enumeradas y sus hábitas críticos están reportados. Esta expansión de rango representa un aumento de casi 275km de distancia lineal hacia el oeste del Condado Trinity en el este de Texas hasta el Condado Hays en la parte oriental de la Meseta Edwards y el margen occidental de las ecoregiones Pradera Blackland. Es probable que P. repens no sea una introducción reciente, solamente en los últimos 3 a 5 años, en el Río San Marcos porque un área de más de 0.4 hectáreas fue observada el 9 de noviembre de 2012, justamente bajo la Represa Cummings con pequeñas partes dispersas río abajo. La habilidad de las especies para reproducirse asexualmente e invadir nuevas áreas crea una amenaza severa para las especies en peligro de extinción y sus hábitats críticos en el Río San Marcos.

Panicum repens L., torpedograss, is a C_4 grass native to Europe, Asia, and Africa (Hossian et al. 1999). The species is considered one of the world's most aggressive grass weeds in agriculture (Holm et al. 1977) and natural areas (Langeland et al. 2008). It is widely naturalized throughout the New World tropics and subtropics (Sutton 1996; Langeland et al. 2008). The species is currently distributed throughout the southeastern United States, California, and Hawaii (Langeland et al. 2008). In Texas, the species is documented from herbarium records in six counties (Cameron, Chambers, Galveston, Jefferson, Matagorda, and Trinity) in the eastern part of the state (Shaw et al. 2011; Shaw 2012). An additional voucher specimen of *P. repens* exists from Montgomery County (Roger W. Sanders 6283, TEX 00207360) and un-vouchered observations are recorded for Calhoun and Harris counties (Jason Singhurst, unpubl. data). It is listed as a noxious weed by the Texas Department of Agriculture (TDA 2013) and a prohibited exotic species by the Texas Parks and Wildlife Department (TPWD 2013).

The species is a perennial grass that can grow to heights of 1 meter. It is mat-forming in water spreading from an extensive network of rhizomes and stolons. The common name refers to the sharp-pointed torpedo-like tips of the rhizomes. *Panicum repens* is known to form extensive mats in water 0.6 to 1.2 meters deep, displacing native aquatic plants (Tarver 1979). Rhizomes and stolons can grow to lengths of 6 meters (Langeland 1998). The species invades a wide variety of habitats and can be found growing in aquatic, riparian, wetland, and terrestrial habitats in the southeastern United States, but thrives in wetland and riparian habitat. Its invasive potential is due to its ability to establish in new areas from short stem fragments, rhizomes, and stolons (Sartain 2003). Non-native grasses may have the ability to alter regional and even global aspects of ecosystem function (D'Antonio & Vitousek 1992). Being a C_4 grass, *P. repens* would have an advantage over native C_3

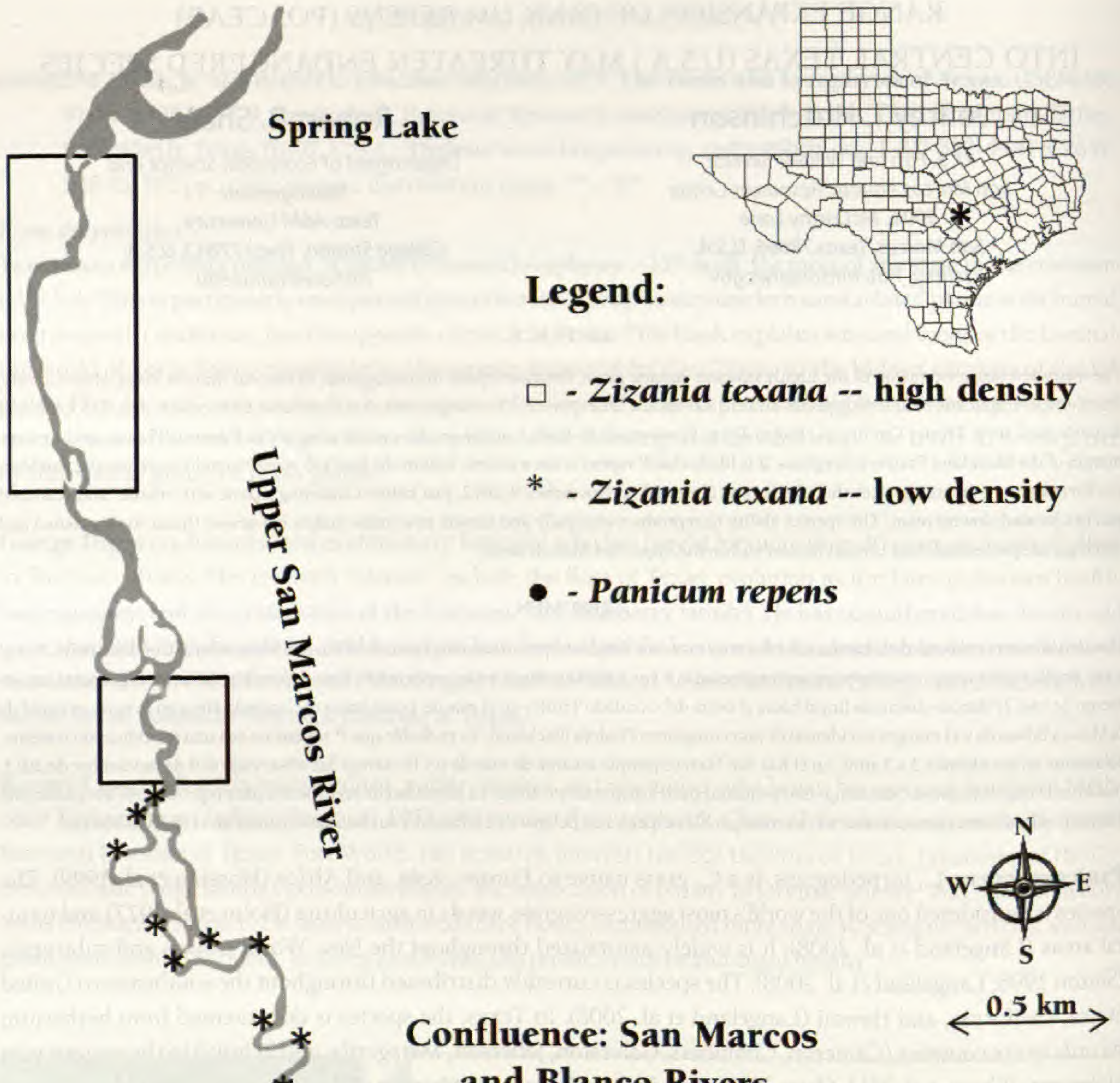

Fig. 1. Locations of the San Marcos River in relation to Texas and *Panicum repens* in the upper San Marcos River in relation to *Zizania texana*.

grasses, such as the endangered *Zizania texana* Hitch., by its ability to sequester limited CO_2 during droughts, low flows, and high water temperatures without photorespiration (Keeley & Rundel 2003). In Florida, *P. repens* became established in over 5,665 ha (14,000 acres) in Lake Okeechobee and changed the structure and composition of the marsh forming a monoculture (Schardt 1994). Seed germination rates are highly variable, but

higher rates were reported for *P. repens* seeds under fluctuating temperatures (Martinez et al. 1992). Based on the current literature, it is unlikely that *P. repens* seeds have high germination rates in the southeastern United States (Wilcut et al. 1988).

The San Marcos River is spring-fed and supports a high diversity of threatened and endangered species including *Z. texana*, *Eurycea rathbuni* Stejneger 1986 (Texas blind salamander), *Eurycea nana* Bishop 1941 (San Marcos salamander), *Etheostoma fonticola* Jordan & Gilbert 1886 (fountain darter), and *Heterelmis comalensis* Bosse, Tuff & Brown 1988 (Comal Springs riffle beetle). An endemic species of fish *Gambusia georgei* Hubbs & Peden 1969 (San Marcos gambusia) once found in the river is thought to be extinct. The upper 7.2 km of the San Marcos River, from the headwaters at Spring Lake to the confluence with the Blanco River, is considered to be one of the most diverse spring runs in Texas and is designated as critical habitat by the United States Fish and Wildlife Service (USFWS 1996). Classification as critical habitat indicates a geographical area has all the attributes needed for long-term success of endangered species' but may require special management and protection measures to ensure species long-term survival. Threats to listed species in the upper San Marcos River include dams, siltation, floods, decreased aquifer levels, low flows, recreation, and non-native species (Terrell et al. 1978; USFWS 1996).

We believe that the similarity in habitat shared by *P. repens* and *Z. texana* is cause for concern. The most upstream population of *P. repens* was observed less than 1 km from critical habitat and ca. 2.3 km from the nearest population of *Z. texana* (Fig. 1). Based on our observations of *P. repens* just below Cumming's Dam, the species exhibits the ability to form monocultures along littoral and riparian habitat, as well as spreading into uplands. This species has the ability to spread into critical habitat occupied by *Z. texana* from accidental or natural movements of small stem fragments, rhizomes, and stolons upstream. In greenhouse studies, small sections of *P. repens* stems with nodes produce roots in 1 day, and 79% of tiller segments and 93% of shoot segments produced new vegetative growth within four weeks (Sartain 2003). *Panicum repens* and *Z. texana* both prefer open sunlight and reproduce vegetatively by rhizomes or tillers. *Zizania texana* is found at a mean water depth of 0.75 m (Poole & Bowles 1999) which lies within the range where *P. repens* is documented to form dense monocultures (Tarver 1979).

The presence of *P. repens* just outside of critical habitat and the possibility that it could be introduced further upstream poses a threat to native species of flora and fauna in the San Marcos River. The establishment of *P. repens* within critical habitat, combined with the effects of other established non-native plants such as *Hydrilla verticillata* (L.f.) Royle (hydrilla), *Hygrophila polysperma* (Roxb.) T. Anderson (East Indian hygrophila), *Cryptocoryne beckettii* Thuill. ex R. Trim (Beckett's water trumpet), and *Colocasia esculenta* (L.) Schott (wild taro) could result in additional habitat loss for *Z. texana*, other native aquatic plants, threatened and endangered species, and alteration of the habitat structure on which they are dependent for survival.

Voucher specimen: **TEXAS. Hays Co.:** San Marcos, San Marcos River (29°51'21"N, 97°54'19"W), ca. 45 m downstream of Cummings Dam on S bank, 0.4 ha in area, riparian and terrestrial, scattered patches downstream, 9 Nov 2012, *J. Hutchinson s.n.* (TAES). Verified by R. Shaw.

ACKNOWLEDGMENTS

We thank employees at the USFWS's San Marcos Aquatic Resources Center, Robert Doyle, Kenneth Langeland, and Jackie Poole for their review of this manuscript. Official journal reviews by Jason Singhurst and David E. Lemke are much appreciated. Jackie Fernandez and Javier Gomez generously provided the Spanish translation of the abstract. The views expressed in this manuscript are the views of the authors and do not reflect the views of the U.S. Fish and Wildlife Service.

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ANNOTATED CHECKLIST OF THE VASCULAR FLORA OF THE WIND RIVER RANGE, WYOMING (U.S.A.)

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ABSTRACT

More than 100 botanists have collected vascular plant specimens from the Wind River Range in northwestern Wyoming, U.S.A., and at least seven floristic surveys have been conducted in portions of the range. Until now, however, no comprehensive checklist has been developed for the area. We collected or examined over 28,600 specimens from the Wind Rivers to compile an annotated checklist of 1282 species and varieties, representing nearly 45 percent of the flora of Wyoming. The species richness of the Winds is second only to Yellowstone National Park in western Wyoming. This can be attributed to the presence of a variety of substrates, broad elevation range, and diversity of vegetation types. Ten subregions are recognized within the Wind Rivers that differ in geology, climate, elevation, and floristic diversity. From a conservation perspective, the Wind River Range is significant for having 82 rare plant species and in having three-quarters of its plant taxa present in wilderness areas or other formally protected lands.

RESUMEN

Más de 100 botánicos han colectado especimenes de plantas vasculares en la Wind River Range en el noroeste de Wyoming, U.S.A., y al menos se han llevado a cabo siete estudios florísticos en partes de la cordillera. Hasta ahora, sin embargo, no se ha desarrollado ningún catálogo global para el área. Hemos colectado o examinado más de 28,600 especimenes de los Wind Rivers para compilar un catálogo anotado de 1282 especies y variedades, que representan cerca del 45 por ciento de la flora de Wyoming. La riqueza de especies de los Winds es la segunda solo después del Yellowstone National Park en el oeste de Wyoming. Esto pude ser atribuido a la presencia de una variedad de substratos, amplio rango de elevación, y diversidad de tipos de vegetación. Se reconocen diez subregiones dentro de los Wind Rivers que difieren en geología, clima, elevación, y diversidad florística. Bajo la perspectiva de la conservación, la Wind River Range es significativa por tener 82 especies de planta raras y por tener tres cuartos de sus taxa vegetales presentes en áreas salvajes u otros espacios protegidos formalmente.

INTRODUCTION

The Wind River Range is located at the southern edge of the Central Rocky Mountains (Peet 2000) and Greater Yellowstone ecosystem in northwestern Wyoming. These mountains, "named for flowing water named for moving air" (Kelsey 1988) are the largest and highest range in the state (Blackstone 1993). More than 40 peaks exceed 3800 m (12,500 ft). The tallest, Gannett Peak at 4208 m (13800 ft), is the highest point in the Rocky Mountains between Canada and Colorado (Kelsey 1988). Scattered among these peaks is the second largest concentration of glaciers within the contiguous United States and one of the most extensive areas of alpine tundra (Scott 1995).

In June 1834, Thomas Nuttall collected the holotype of *Eriogonum acaule* at South Pass at the southern edge of the Wind River Range, making him the first botanist to study the flora of the area (Dorn 1986). More than 100 plant collectors have followed in Nuttall's footsteps, including John C. Fremont, Aven Nelson, Elmer D. Merrill, Edwin B. Payson, Cedric L. Porter, Frederick J. Hermann, Rupert C. Barneby, Reed C. Rollins, and

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Erwin F. Evert. Since the mid-1960s, seven graduate students from the University of Wyoming's Rocky Mountain Herbarium (RM) have conducted floristic surveys of portions of the range. The purpose of this paper is to compile an annotated checklist of the vascular flora of the Wind River Range based on a synthesis of the existing literature and specimen databases of the RM (Hartman et al. 2009) and other regional herbaria. The paper will also highlight the biogeographic patterns and conservation significance of the area. The inventory of the Wind River Range is part of a larger effort by RM to document the flora of the middle and southern Rocky Mountains over the past 35 years (Hartman 1992) that has generated more than 50 master's theses and over 650,000 herbarium collections.

METHODS

The species list (Table 1) was derived from a review of unpublished floristic theses, natural area inventory reports, and rare species surveys conducted in the Wind River Range since the 1960s (Cramer 1997; Evert 2010; Fertig 1992, 1995a, 1995b, 1997, 1998; Haines 1988; Kinter 2000; Massatti 2007; Mills & Fertig 1996; Newton 2008; Rosenthal 1999; Scott 1966, 1995). Additional reports were found in the collections of the RM and Central Wyoming College (CWC) and records from the Wyoming Natural Diversity Database. At least one collection representing each species from the study area was re-verified at RM to corroborate its presence. Misidentified or falsely reported species from the Wind Rivers are listed in Table 2. Species nomenclature follows the RM Plant Specimen Database (Hartman et al. 2009), which itself is based on Dorn (2001) and more recent literature (including Barkworth 2003, 2007; Ertter 2007; Flora of North America Editorial Committee 1993+; Holmgren et al. 2005, 2012; Mast & Reveal 2007; Nesom 2006; Wagner et al. 2007). Family names are based on the Angiosperm Phylogeny Group (2009) classification. Each species entry in the checklist is annotated with additional information on the number of collections from the area, distribution within the Wind Rivers (by subregions), elevation range, and general habitat types. Synonyms are provided for names that differ from Dorn (2001), Fertig (1992), or Massatti (2007). Additional codes indicate species that are historical, introduced, or of conservation concern.

STUDY AREA

Setting. The Wind River Range straddles the Continental Divide from Togwotee Pass to South Pass, a distance of 177 km (110 miles). At its northern end, the Wind Rivers are bordered by the Absaroka and Gros Ventre ranges and the valley of the Buffalo Fork of the Snake River. To the east, south, and west, the range is bounded by the Wind River, Great Divide, and Green River basins, respectively (Fig. 1). The entire range covers an area of approximately 7800 square km (3010 square miles). For the purpose of this study, we excluded the Brooks Lake area and Dunoir Valley northeast of U.S. Highway 26/287, which is included in the Wind Rivers by some authors (Rosenthal 1999), because it is better considered part of the Absaroka Range.

The area is divided between Fremont, Sublette, and Teton counties. More than 80 percent of the Wind River Range is managed by the U.S. Forest Service. The area west of the Continental Divide is located within Bridger-Teton National Forest, while the lands to the east are part of Shoshone National Forest. More than half of the Forest Service lands are within three Congressionally-designated Wilderness Areas: Bridger, Fitzpatrick, and Popo Agie. About one-quarter of the east slope of the range is in the Wind River Indian Reservation. The foothills of the Wind Rivers include small parcels of private, state, and federal lands managed by the Bureau of Land Management (BLM). Several small towns are located in the foothills of the range, including Pinedale on the west side, Lander off the southeast slope, and Dubois along the northeast boundary.

Climate. The Wind River Range lies in a partial rain shadow created by the Teton, Gros Ventre, Salt River, and Wyoming ranges to the west and southwest. The higher elevations of the Wind Rivers receive 132–152 cm of precipitation per year, with about 65 percent falling as snow (Martner 1986; Potkin 1991). Precipitation is greatest at the northern end of the range and decreases southward (PRISM Climate Group 2007). Annual precipitation in the foothills averages 20–38 cm. Most precipitation occurs in April and May, with a secondary peak in September and October (Western Region Climate Center 2007).

TABLE 1. Summary of vascular plant taxa of the Wind River Range.

Category	Number of Taxa in Wind River Range	Percentage of Wind River Flora
Taxonomy		
Total taxa	1282	100
Full species	1190	92.8
Additional varieties or subspecies	92	7.2
Fern allies	8	0.6
Ferns	13	1.0
Gymnosperms	11	0.9
Angiosperms	1250	97.5
Monocots	300	23.4
Dicots	950	74.1
Other Status		
Native taxa	1183	92.3
Introduced taxa	99	7.7
Noxious weed taxa	14	1.1
Taxa of Conservation Concern	82	6.4
Vegetation Types		
Alpine tundra (at)	297	23.1
Aquatic (aq)	69	5.4
Aspen forests (af)	332	25.9
Badlands (bd)	79	6.2
Big sagebrush grasslands (bs)	607	47.3
Disturbed sites (ds)	301	23.5
Douglas-fir forests (df)	158	12.3
Dry meadows (dm)	693	54.0
Forested wetlands (fw)	384	29.9
Granite and gneiss outcrops (gr)	409	31.9
Juniper woodlands (jw)	119	9.3
Limber pine woodlands (lw)	82	6.4
Limestone and calcareous outcrops (lm)	286	22.3
Lodgepole pine forests (lf)	324	25.3
Marshes and bogs (ma)	220	17.1
Riparian shrublands (non-willow) (rs)	96	7.5
Sand and gravel bars (sa)	288	22.4
Spruce-fir forests (sf)	263	20.5
Wet meadows (wm)	572	44.6
Whitebark pine forests (wf)	121	9.4
Willow thickets (wt)	355	27.7
Geographic Subregions (numbers in parentheses are taxa restricted to each subregion)		
Boulder Creek drainage (B)	686 (17)	53.5
Dinwoody Creek drainage (D)	525 (14)	40.9
Fremont Lake (F)	877 (65)	68.4
Green River Lakes (G)	521 (15)	40.6
Limestone Mountain (L)	592 (77)	46.2
Moccasin Basin (M)	517 (12)	40.3
Popo Agie River drainage (P)	595 (13)	46.4
South Pass (S)	377 (18)	29.4
Torrey Lake (T)	546 (31)	42.6
Warm Spring Creek drainage (W)	524 (15)	40.8

Temperature data are primarily available from weather stations located in the foothills of the range. Average annual temperature ranges from 2.1° C in Pinedale (elevation 2187 m) to 7° C in Lander (elevation 1632 m). Daily average minimum and maximum temperatures in January vary from -3° C and18° C in Pinedale to -12° C and 0° C in Dubois (elevation 2115 m). In July, average minimum and maximum temperatures range from 5° C and 25° C in Pinedale to 13° C and 30° C in Lander (Martner 1986; Western Region Climate Center 2007).

Table 2. Species rejected from the annotated checklist of the flora of the Wind River Range (based on Fertig 1992; Haines 1988; Massatti 2007; Newton 2008; Rosenthal 1999; and RM records).

Apiaceae
Shoshonea pulvinata Evert & Const. (collection is east of Wind River Range)
Asteraceae
Artemisia tridentata Nutt. var. *spiciformis* (Osterh.) Dorn (misidentified, = *A. arbuscula*)
Erigeron nanus Nutt. (misidentified, = *E. concinnus* var. *concinnus*)
Gutierrezia sarothrae (Pursh) Britt. & Rusby (collection is east of Wind River Range)
Helianthus nuttallii Torrey & Gray (misidentified, = *Helianthella uniflora*)
Hymenopappus filifolius Hook. var. *luteus* (Nutt.) Turner (misidentified, = *H. polycephalus*)
Dieteria canescens (Pursh) Nutt. var. *glabra* (Gray) Morgan & Hartman (misidentified, = *Symphyotrichum spathulatum*)
Pyrrocoma clementis Rydb. var. *villosa* (Rydb.) Mayes ex Brown & Keil (misidentified, = var. *clementis* and *P. integrifolia*)
Solidago mollis Bartl. (misidentified, = *S. velutina*)
Stephanomeria tenuifolia (Raf.) Hall (misidentified, = *S. fluminea*)
Tragopogon miscellus Ownbey (misidentified, = *T. pratensis*)
Boraginaceae
Cryptantha circumcissa (H. & A.) Johnston (misidentified, = *Plagiobothrys scouleri*)
Brassicaceae
Erysimum asperum (Nutt.) DC. var. *asperum* (misidentified, = *E. capitatum* var. *capitatum*)
Physaria eburniflora Roll. (misidentified, = *P. saximontana*)
Caprifoliaceae
Symphoricarpos albus (L.) Blake var. *laevigatus* (Fern.) Blake (misidentified, = *S. oreophilus*)
Caryophyllaceae
Minuartia dawsonensis (Britt.) House (misidentified, = *M. austromontana*)
Cyperaceae
Carex nova Bailey var. *nova* (misidentified, = var. *pelocarpa*)
Carex scirpoidea Michx. var. *scirpiformis* (Mack.) O'Neill & Duman (misidentified, = var. *pseudoscirpoidea*)
Scirpus microcarpus Presl (collection is west of Wind River Range)
Ericaceae
Vaccinium cespitosum Michx. (misidentified, = *V. membranaceum*)
Fabaceae
Astragalus miser Dougl. var. *oblongifolius* (Rydb.) Cronq. (misidentified, = var. *decumbens*)
Astragalus shortianus Nutt. (misidentified, = *A. missouriensis*)
Lupinus leucophyllus Dougl. ex Lindl. (misidentified, = *L. argenteus* var. *argophyllus* and *L. sericeus*)
Oxytropis sericea Nutt. var. *spicata* (Hook.) Barneby (misidentified, = var. *sericea*)
Trifolium parryi Gray var. *parryi* (misidentified, = var. *montanense*)
Grossulariaceae
Ribes oxyacanthoides L. var. *oxyacanthoides* (mis-identified, = var. *setosum*)
Hydrocharitaceae
Elodea canadensis Michx. (misidentified, = *E. bifoliata* & *E. nuttallii*)
Orobanchaceae
Penstemon cyananthus Hook. (misidentified, = *P. subglaber*)
Parnassiaceae
Parnassia parviflora DC. (misidentified, = *P. palustris* var. *montanensis*)
Phrymaceae
Mimulus glabratus H.B.K. var. *jamesii* (T. & G. ex Benth.) Gray (holotype of *M. glabratus* var. *fremontii* cited as "Wind River Range" on Fremont's label, but actually collected in Laramie Range by Fremont according to Cronquist et al. (1984).
Poaceae
Agrostis capillaris L. (misidentified, = *A. stolonifera*)
Puccinellia nuttalliana (Schultes) Hitchc. (specimen has not been relocated at RM; location outside expected range)
Polygonaceae
Eriogonum heracleoides Nutt. (historical collection from RM cannot be relocated and is presumed annotated)
Eriogonum umbellatum Torrey var. *dichrocephalum* Gand. (collection is west of Wind River Range)
Rosaceae
Agrimonia gryposepala Wallr. (historical collection by T.A. Williams has vague locality data but is probably from east of Wind River Range)
Potentilla hippiana Lehm. var. *hippiana* (misidentified, = *P. concinna* or *P. hippiana* var. *effusa* hybrids)
Rosa arkansana Porter (misidentified, = *R. sayi*)
Sarcobataceae
Sarcobatus vermiculatus (Hook.) Torrey (collection is west of Wind River Range)
Themidaceae
Triteleia grandiflora Lindl. (report from Dubois area based on collection from Jackson Hole)
Verbenaceae
Glandularia bipinnatifida (Nutt.) Nutt. (historical collection by T.A. Williams has vague locality data but is probably from east of Wind River Range)
Violaceae
Viola mackloskeyi Lloyd var. *pallens* (Banks ex DC.) Hitchc. (misidentified, = *V. palustris*)
Viola nuttallii Pursh (misidentified, = *V. praemorsa*)

By contrast, Titcomb Basin (elevation 3200 m; 10500 ft) near the Continental Divide has an average temperature of -3.3° C, and ranges from -15° C in January to 9.4° C in July (Kelsey 1988).

Geology. The core of the Wind River Range is a block of uplifted Precambrian crust approximately 160 km long by 55 km wide. This block consists of 3.4–3.8 billion year old metamorphic migmatite and gneiss intruded by 2.5–2.7 billion year old igneous granite (Koesterer et al. 1987). Younger Paleozoic and Mesozoic marine sedimentary formations are exposed along the eastern flank of the Wind Rivers and in the vicinity of the Green River Lakes on the west slope (Worl et al. 1986). These formations include the Cambrian Gallatin limestone, Gros Ventre shale, and Flathead limestone, Ordovician Bighorn dolomite, Mississippian Madison

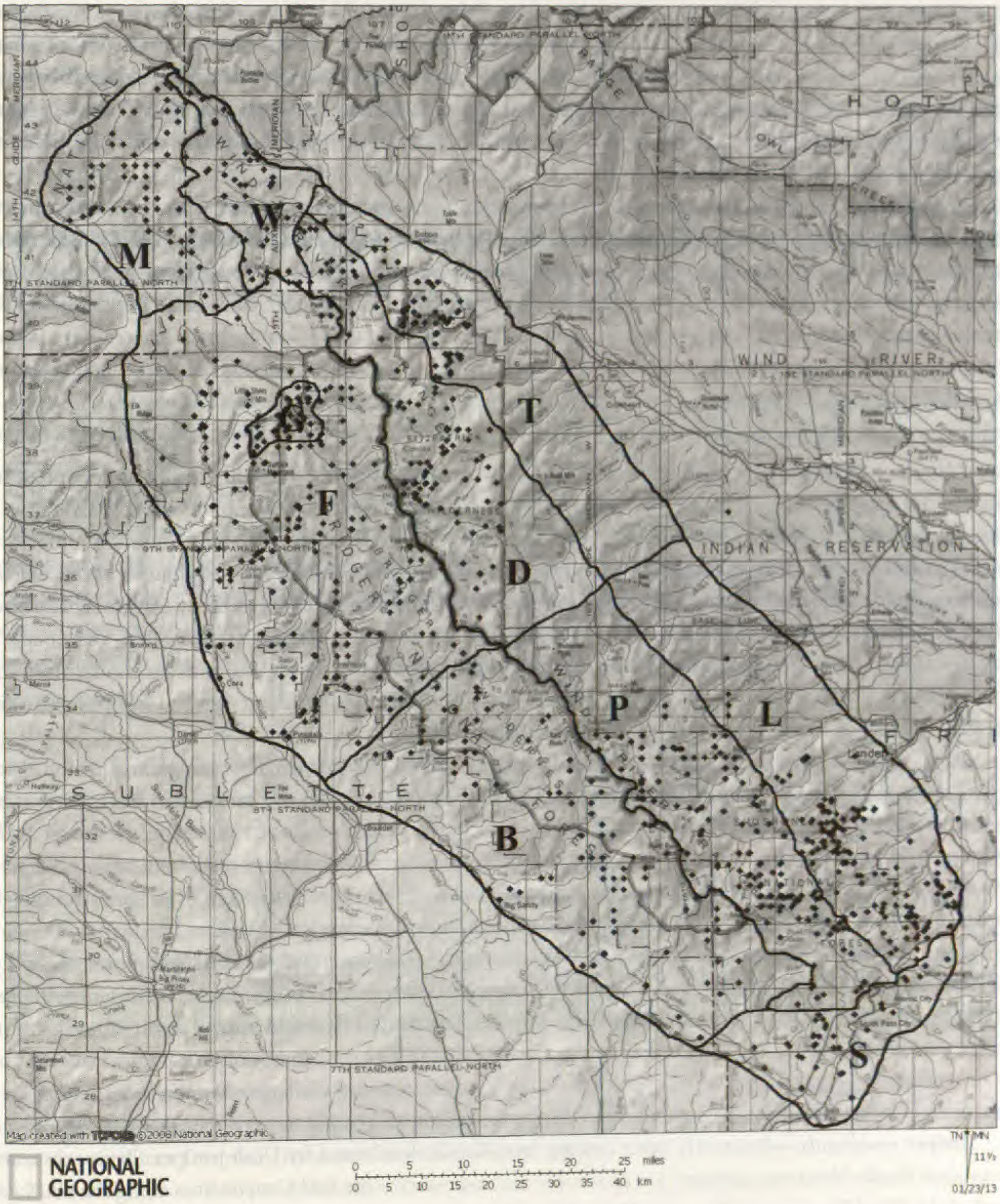

Fig. 1. Map of the Wind River Range in western Wyoming. Collection sites from recent floristic surveys and specimen data from RM are indicated by black diamonds. Geographic subregions within the range are indicated by capital letters (B = Boulder Creek drainage, D = Dinwoody Creek drainage, F = Fremont Lake, G = Green River Lakes, L = Limestone Mountain, M = Moccasin Basin, P = Popo Agie River drainage, S = South Pass, T = Torrey Lake, W = Warm Spring Creek drainage).

limestone, Permian Phosphoria, Triassic Chugwater, and Jurassic Nugget sandstone. A mixture of Lower Tertiary and Upper Cretaceous sedimentary and igneous rocks is exposed between Union Pass and Togwotee Pass, including the Wind River, Aycross, and Devils Basin formations (Lageson & Spearing 1988; Love & Christiansen 1985). Quaternary glacial deposits and Tertiary gravels bury large areas on the west flank of the range and in the Union Pass area (Worl et al. 1986).

The modern terrain of the Wind River Range has been sculpted by Pleistocene glaciation. In the last 200,000 years there have been at least three major glacial advances (Lageson & Spearing 1988). The scouring action of glaciers produced the large cirques, sharp-crested peaks, and U-shaped valleys common in the mountains (Worl et al. 1986) as well as erratic boulders, moraines, and large glacial lakes in the foothills. Several large glaciers still exist, mostly just east of the Continental Divide, and some of these show evidence of advancing in the past 100–2100 years (Mears 1997).

Vegetation. The vegetation of the Wind River Range and northwestern Wyoming has been described in detail by Evert (2010), Gregory (1983), Habeck (1987), Knight (1994), Potkin (1991), Reed (1971, 1976), Tweit and Houston (1980), Walford et al. (2001), Youngblood and Mueggler (1981), and Youngblood et al. (1985). We recognize twenty-one general vegetation types for the Wind Rivers (Fertig 1992; Massatti 2007) based on differences in physiognomy (forests/woodlands, shrublands, and forb/graminoid meadows), topography (slopes or depressions), soil moisture, elevation zone (foothills, montane, subalpine, or alpine), and substrate (sand, clay, limestone, or granite/gneiss).

FORESTS AND WOODLANDS

Aspen forests.—Quaking aspen (*Populus tremuloides*) is common from the foothills to the upper subalpine zones in the Wind River Range, especially in areas with a history of disturbance or on relatively calcareous or mesophytic soils derived from sedimentary formations (Youngblood & Mueggler 1981). Common understory species include *Symphoricarpos oreophilus, Mahonia repens, Artemisia tridentata* var. *vaseyana, Arnica cordifolia, Lupinus argenteus, Geranium viscosissimum,* and *Astragalus miser.* Stands that are grazed by cattle or sheep often have an understory dominated by *Frasera speciosa, Hymenoxys hoopesii, Arctostaphylos uva-ursi*, and *Juniperus communis* (Reed 1971; Youngblood & Mueggler 1981). Aspen stands are usually seral to other coniferous forest types, though climax aspen forests may occur in a band between low elevation sagebrush grasslands and Douglas-fir or spruce-fir forests in the Wind Rivers (Reed 1971).

Douglas-fir forests.—Forests dominated by Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) in the Wind River Range occur primarily on steep, north exposures in the foothills and lower montane zones on limestone or sedimentary soils (Reed 1976). Spruce-fir forests typically replace Douglas-fir on higher elevation acidic soils derived from gneiss or granite. Common understory species include *Juniperus communis, Mahonia repens, Symphoricarpos oreophilus, Poa wheeleri,* and *Festuca idahoensis* (Steele et al. 1983). On drier sites, Douglas-fir forests intergrade with big sagebrush grasslands and limber pine woodlands.

Forest wetlands.—This broad category includes swamps, lakeshores, and streamsides dominated by Engelmann spruce (*Picea engelmannii*), blue spruce (*P. pungens*), narrowleaf cottonwood (*Populus angustifolia*), quaking aspen, or other tree species (Fertig 1992). Forested wetlands differ from upland forest types by occurring on wetter and more poorly-drained soils (usually in drainage bottoms) and by often having a richer herbaceous understory. Typical understory species include *Carex microptera, Calamagrostis canadensis, Bromus ciliatus, Senecio triangularis, Saxifraga odontoloma, Mertensia ciliata,* and *Equisetum arvense* (Massatti 2007).

Juniper woodlands.—Relatively open canopy woodlands dominated by Utah juniper (*Juniperus osteosperma*) or Rocky Mountain juniper (*J. scopulorum*) are restricted to the Red Canyon area along the southeast flank of the Wind River Range (Massatti 2007). This vegetation type occurs on siltstone and sandstone-derived soils. Common understory species include *Artemisia tridentata, Leucopoa kingii, Purshia tridentata*, and *Rhus trilobata* (Massatti 2007).

Limber pine woodlands.—Limber pine (*Pinus flexilis*) forms open woodlands on dry slopes and ridges in the foothills of the Wind River Range (Steele et al. 1983). Stands usually occur on south exposures over well-drained, rocky, sedimentary soils. Common associated species include *Shepherdia canadensis, Juniperus communis, Symphoricarpos oreophilus, Leucopoa kingii, Carex rossii,* and *Festuca idahoensis.*

Lodgepole pine forests.—Forests dominated by lodgepole pine (*Pinus contorta* var. *latifolia*) cover extensive areas of the foothill, montane, and subalpine zones of the Wind River Range. Lodgepole pine may form nearly pure stands following severe disturbances, especially fire. Stands are usually seral to other coniferous forest types, but climax lodgepole pine forests can persist on dry, cool, or relatively infertile sites (Steele et al. 1983).

Seral and climax lodgepole pine forests tend to have low species richness (Reed 1976). Typical species from the understory include *Juniperus communis, Vaccinium scoparium, Arnica cordifolia, Carex rossii, Poa wheeleri, Achillea millefolium, Antennaria rosea*, and *Potentilla diversifolia. Calamagrostis rubescens* and *Carex geyeri*, two species that are often dominant in lodgepole pine communities elsewhere in western Wyoming, are absent or rare in the Wind Rivers (Steele et al. 1983).

Spruce-fir forests.—Subalpine fir (*Abies bifolia*) and Engelmann spruce (*Picea engelmannii*) are the dominant tree species in the montane and subalpine forests of the Wind Rivers. *Abies bifolia* is more likely to be dominant (with *P. engelmannii* being seral) on well drained, dry to mesic sites (Reed 1976; Steele et al. 1983). *Picea engelmannii* tends to be dominant or co-dominant on wetter or higher elevation sites or areas with periodic disturbance (Peet 2000; Steele et al. 1983). Potkin (1991) found the understories of different spruce-fir habitat types to be floristically similar and relatively depauperate. Typical understory species include *Vaccinium scoparium, Shepherdia canadensis, Juniperus communis, Arnica cordifolia, Antennaria microphylla, Carex rossii*, and *Poa wheeleri. Calamagrostis rubescens, Carex geyeri*, and *Spiraea betulifolia* are common understory species in spruce-fir forests of the Teton and Wyoming ranges, but are rare to absent in the Wind Rivers (Steele et al. 1983).

Whitebark pine forests.—Whitebark pine (*Pinus albicaulis*) occurs mostly from upper timberline to the upper montane elevation zone, where it is usually subdominant to subalpine fir and Engelmann spruce. Forests dominated by whitebark pine are limited to ridges and slopes exposed to extreme cold, high winds, and drought conditions unsuitable to spruce-fir forest (Reed 1976; Steele et al. 1983). Species commonly found in these stands include *Vaccinium scoparium, Arnica cordifolia, Carex rossii, Poa wheeleri, Juniperus communis*, and *Ribes montigenum*. These forests have been impacted by blister rust in the past decade.

SHRUBLANDS

Big sagebrush grasslands.—Shrub steppe dominated by mountain big sagebrush (*Artemisia tridentata* var. *vaseyana*) is the most widespread non-forested vegetation type in the Wind River Range. This type occurs on upland sites from the foothills to the lower subalpine on well-drained, sandy, or coarse-textured soils (Knight 1994). Common associated species include *Festuca idahoensis, Elymus spicatus, E. trachycaulus, Poa fendleriana, P. secunda, Achnatherum nelsonii, Koeleria macrantha, Purshia tridentata*, and *Ericameria nauseosa*. Dry, rocky slopes and talus in the sagebrush zone are often locally dominated by other shrub species, such as *Acer glabrum, Amelanchier alnifolia, Cornus sericea*, or *Symphoricarpos oreophilus* (Fertig 1992).

Riparian shrublands (non willow).—Riparian shrublands are a relatively minor vegetation type found along streams, lakes, and moist, low-lying depressions, These communities are dominated by a mix of shrub species that does not include willows or trees. The most common dominants are *Betula occidentalis, B. glandulosa, Cornus sericea, Lonicera involucrata*, and *Prunus virginiana*. Typical understory species include *Equisetum arvense, Heracleum sphondylium, Poa pratensis, Calamagrostis canadensis*, and *Carex microptera* (Fertig 1992). In some low elevation areas silver sagebrush (*Artemisia cana* var. *viscidula*) may dominate streambank communities, with or without *Dasiphora fruticosa* (Youngblood et al. 1985).

Willow thickets.—Willow (*Salix* spp.) thickets are the most widespread riparian shrub vegetation type in the Wind River Range (Walford et al. 2001; Youngblood et al. 1985). Willow stands occur from the foothills to above timberline and share a common physiognomy, but differ in the dominant species of *Salix*. At lower elevations, stands are dominated by *Salix boothii, S. wolfii*, or *S. geyeriana* with an understory of *Deschampsia cespitosa, Geum macrophyllum, Agrostis stolonifera*, and *Poa pratensis*. In the subalpine zone, *Salix planifolia* (or occasionally *S. eastwoodiae*) becomes predominant (Walford et al. 2001). Willow communities in the alpine tend to be dominated by *Salix glauca* on well-drained mineral soils and *S. planifolia* on wetter sites (Potkin 1991).

FORB- OR GRAMINOID-DOMINATED VEGETATION

Alpine tundra.—Alpine tundra is restricted to the area above upper treeline on the highest peaks of the Wind River Range. This vegetation type is similar to the dry meadows characteristic of subalpine and montane zones, but is dominated by mat or cushion-forming forbs, dwarf shrubs, and low bunchgrasses (Scott 1966, 1995). Among the more common species are *Geum rossii, Salix arctica, S. reticulata, Selaginella densa, Silene acaulis*,

Minuartia obtusiloba, and *Carex elynoides*. Alpine tundra blends into woodlands of stunted *Picea engelmannii*, *Abies bifolia*, and *Pinus albicaulis* at upper timberline, which is sometimes treated as a distinct vegetation type (Fertig 1992).

Aquatic.—Aquatic vegetation consists of free-floating, submerged, or emergent forb and graminoid species found within lakes, ponds, and slow-moving streams from the foothills to the subalpine of the Wind River Range (Fertig 1992). This minor vegetation type is dominated by *Potamogeton* and *Stuckenia* spp., *Callitriche palustris, Ranunculus aquatilis, Carex utriculata, Sparganium angustifolium*, and *Alopecurus aequalis*.

Badlands.—Sparsely vegetated badland communities are a minor type found sporadically in the northern foothills of the Wind River Range on open, highly eroded, clay-rich slopes and drainage bottoms (Fertig 1992). Common species include *Pyrrocoma uniflora, Lomatium triternatum, Phlox multiflora, Oenothera cespitosa, Astragalus kentrophyta*, and *Antennaria microphylla*.

Disturbed sites.—Disturbed vegetation may be recognized by the dominance of non-native forb and graminoid species (Fertig 1992). In the Wind River Range, this vegetation type occurs chiefly along roadsides, trails, parking lots, or areas that have been logged, burned, or used heavily by livestock. Typical species include *Bromus inermis, B. tectorum, Phleum pratense, Poa pratensis, Taraxacum officinale, T. erythrospermum, Capsella bursa-pastoris, Cirsium arvense, Thlaspi arvense*, and *Tragopogon dubius*.

Dry meadows.—Dry meadow communities are park-like openings in upland sites from the foothills to upper treeline dominated by perennial grasses and forbs with little to no mountain big sagebrush. These sites often occur on relatively well-drained, fine-textured alluvial or colluvial soils with a dense sod that inhibits the establishment of forests (Peet 2000). Common species include *Festuca idahoensis, Elymus spicatus, E. trachycaulus, Lupinus argenteus*, and *Ligusticum filicinum*. Dry meadows in the Range with a history of sheep grazing tend to become dominated by *Achnatherum lettermanii, Trisetum spicatum, Achillea millefolium*, and *Agoseris glauca* (Potkin 1991).

Granite or gneiss outcrops.—Exposed granite or gneiss bedrock, cliff faces, talus slopes, and boulder fields are common along the Continental Divide and can extend into the foothill zone on the west side of the Wind River Range. These sites are frequently disturbed by rock slides and have shallow, xeric soils due to exposure to high winds (Gregory 1983). Vegetative cover is sparse and consists mostly of bunchgrasses or forbs (sites with high sagebrush or montane shrub cover are classified as big sagebrush grasslands). At lower elevations, granitic outcrops tend to be dominated by *Balsamorhiza sagittata, Eriogonum umbellatum*, and *Elymus trachycaulus*. At upper treeline and above, granite outcrops are commonly inhabited by *Oxyria digyna, Erigeron compositus, Trisetum spicatum, Hymenoxys grandiflora, Antennaria media*, and *Phlox multiflora*.

Limestone or calcareous outcrops.—Cliffs and talus fields derived from limestone sedimentary rocks occur along the east flank of the Wind Rivers and on high peaks adjacent to the Green River Lakes on the west slope. As with granitic outcrops, this community type is characterized by low cover of bunchgrasses and perennial forbs and often lacks shrub or tree species. A suite of calceophilic plant taxa (including many rare species) are restricted to limestone outcrops, such as *Dryas octopetala, Saxifraga oppositifolia, Saussurea weberi, Parrya nudicaulis, Antennaria aromatica*, and *Boykinia heucheriformis*.

Marshes and bogs.—Marshlands dominated by sedges or grasses occur along waterways in valley bottoms and adjacent to shallow lakes and ponds in the foothills and montane zones of the Wind River Range. Sites with saturated or flooded soils are often dominated by *Carex utriculata* (Walford et al. 2001), while drier sites may be dominated by *C. aquatilis* (Youngblood et al. 1985). Other common marsh species include *Calamagrostis canadensis, Deschampsia cespitosa, Poa pratensis*, and *Geum macrophyllum*. Heath bogs occur in similar environments with a high water table in the subalpine zone, but are dominated by low shrubs or forbs (Potkin 1991). Typical bog species are *Kalmia microphylla, Vaccinium occidentale, Deschampsia cespitosa, Juncus drummondii, Pedicularis groenlandica, Caltha leptosepala, Salix planifolia*, and *S. glauca*.

Sand and gravel bars.—This vegetation type occurs on sandy beaches, gravel bars, and mud flats adjacent to lakes, rivers, and streams throughout the Wind Rivers (Fertig 1992). Sites typically have only a modest cover of graminoids and forbs. Common species include *Equisetum arvense, Arnica chamissonis, Rorippa curvipes, Ranunculus flammula, Alopecurus aequalis, Agrostis scabra*, and *Carex athrostachya*.

Wet meadows.—Wet meadows are found along moist streamsides, lakeshores, and floodplains or in low-lying areas that accumulate drifting snow. Similar in appearance to dry meadows, wet meadows are dominated by a thick turf of perennial graminoid and forb species, but relatively few shrubs or trees. Species richness tends to be high in these stands (Tweit & Houston 1980; Youngblood et al.1981). Dominant species may include *Erigeron glacialis, Caltha leptosepala, Mertensia ciliata, Senecio triangularis, Deschampsia cespitosa, Poa pratensis, P. palustris, Calamagrostis canadensis, Juncus arcticus,* and *Carex microptera*. Wet meadows intergrade with dry meadows and alpine tundra but tend to support a different suite of species.

Geographic Subregions. Based on differences in climate, geology, and elevation, the Wind River Range can be divided into geographic subregions that reflect differences in local floristic composition. Fertig (1992) recognized five subregions on the west side of the Continental Divide and Massatti (2007) identified six from the east side. We have modified these subdivisions slightly and revised their names to avoid duplication to derive the following ten geographic subregions for the range (Fig. 1).

Boulder Creek drainage.—Formerly called the South-Central region by Fertig (1992), this subunit extends from Mount Victor and Burnt Lake on the west side of the Continental Divide to Rennecker Peak and the Prospect Mountains. The area includes the south half of the Bridger Wilderness and the Boulder Creek, East Fork, Big Sandy, and upper Sweetwater River drainages. This region is similar to the Fremont Lake subregion to the north in being predominantly gneiss and granite, but has a progressively drier climate and different grazing history (Potkin 1991).

Dinwoody Creek drainage.—This area, located east of the Continental Divide, was previously named the North-Central Region by Massatti (2007). It includes the granite/gneiss core of the northeastern Wind Rivers from Union Peak to Milky Ridge, but excludes the calcareous and sandstone exposures along the east flank of the range (separated out as the Torrey Lake subregion). Most of this region is included within the Fitzpatrick Wilderness Area of Shoshone National Forest.

Fremont Lake.—Previously called the North-Central region by Fertig (1992), this subregion occupies the high elevation granite-gneiss core of the west slope of the Range from the Green River divide and Union Pass south to the Boulder Creek divide between Half Moon and Burnt lakes. The Fremont Lake region includes the north half of the Bridger Wilderness and has a wetter climate than the otherwise similar Boulder Creek region to the south.

Green River Lakes.—This region includes the calcareous mountains (Gypsum Peak, Big Sheep Mountain, and White Rock) and adjacent valley surrounding the Green River Lakes west of the Continental Divide. This is the only area on the west slope of the range that has retained its original mantle of limestone caprock, in sharp contrast to the high elevation gneiss and granite bedrock of the surrounding Fremont Lake region. The flora of the alpine areas of the Green River Lakes shares many rare and disjunct species with Arrow Mountain and other calcareous peaks in the Torrey Lake subregion east of the Divide.

Limestone Mountain.—Located along the southeast flank of the range and formerly known as the Southeast Region (Massatti 2007), the Limestone Mountain area is characterized by sedimentary formations comparable to those along the northeast slope of the Wind Rivers in the Torrey Lake region, but mostly at a lower elevation and with a drier climate. Major features include Red Canyon (the lowest point in the Wind River Range at 1725 m), Fairfield Hill, Limestone Mountain, and the Freak Mountains.

Moccasin Basin.—The Moccasin Basin region is located along the northwestern flank of the Range west of the Continental Divide and encompasses the Cottonwood Creek and Fish Creek drainages between Togwotee Pass and the Green River divide. Most of the basin is comprised of relatively low hills (mostly under 3050 m) with volcanic soils or Tertiary-age claystones and sandstones (Devils Basin, Wind River, and Pinyon formations). Alpine vegetation is restricted to the summit of Two Ocean Mountain, just south of Togwotee Pass (Fertig 1992).

Popo Agie River drainage.—Known as the South-Central region by Massatti (2007), the Popo Agie River region contains the granite-gneiss core of the southern Wind River Range on the east side of the Continental Divide. The area is at lower elevation and has a drier climate than the Dinwoody Creek drainage to the north.

Much of the region is within the Popo Agie Wilderness Area and includes Wind River Peak, the Deep Creek lakes, Cirque of the Towers, and glacial deposits around Louis Lake.

South Pass.—Recognized by both Fertig (1992) and Massatti (2007), this region extends from the south end of the Prospect Mountains and Miner's Delight to South Pass City and Atlantic City east of Wyoming state highway 28. The entire area is located south of the boundary of Bridger-Teton and Shoshone national forests. The region consists of rolling hills with soils derived from sandstone, siltstone, granodiorite, and metasedimentary rocks. South Pass is essentially a broad ecotone between the core of the Wind River Range to the north and high desert basins to the east, south, and west.

Torrey Lake.—Originally named the Northeast Region (Massatti 2007), this area encompasses the sedimentary lower flanks of the east slope of the Wind River Range from Warm Spring Mountain and the foothills west of Dubois south to the Bull Lake area of the Wind River Indian Reservation. This region includes outcrops of the Madison and Gallatin limestones, Bighorn dolomite, Flathead sandstone, and Gros Ventre Formation and alpine summits of Whiskey Mountain, Arrow Mountain, and Dinwoody Peak. The Torrey Lake region shares floristic affinities with the Green River Lakes region on the west slope of the range and the drier Limestone Mountain region to the south.

Warm Spring Creek drainage.—This area (previously known as the North Region by Massatti 2007) is located on the east side of the Continental Divide from Togwotee Pass south to Union Peak and east to Dunoir and the north flank of Union Peak. Most of the subregion is drained by Warm Spring Creek and is underlain by volcanic claystones and basalts of Quaternary gravel, rather than Mesozoic sediments and Precambrian granites and gneiss typical of the regions to the south. Alpine habitats are restricted to the summits of Lava Mountain and Union Peak.

RESULTS AND DISCUSSION

Species Richness. Based on our field work and review of records from RM, CWC, and the literature, there are 1282 vascular plant taxa known from the Wind River Range (Table 1). This total includes 1190 full species and 92 separate varieties or subspecies. At least 32 of these taxa have not been relocated since 1970 and are considered historical. The flora of the Wind Rivers represents 44.6 percent of the vascular flora of Wyoming (2875 taxa; Fertig 2011). These species belong to 407 genera and 91 families (APG 2009). Angiosperms comprise nearly 98 percent of the taxa known from the Range.

An additional 62 species reported for the Wind River Range or vicinity (Fertig 1992; Haines 1988; Massatti 2007; Newton 2008; Rosenthal 1999; RM records) have been excluded from our annotated checklist. Twenty of these taxa are now considered synonyms of other species already known from the flora (these are listed in synonymy in the annotated checklist). Another nine taxa were rejected because the specimens cited for the Wind Rivers were collected beyond our boundaries. The remaining 33 were misidentified (Table 2).

The Wind River flora includes 99 non-native species that account for just 7.7 percent of the entire flora (Table 1). By comparison, introduced species make up 13.6 percent of the flora of Wyoming (Fertig 2011). Fourteen of the 26 officially designated state noxious weed species occur in the Wind River Range (Wyoming Weed and Pest Council 2012).

Since 1987, twelve first records for the state of Wyoming have been documented from the Wind River Range. Richard Scott discovered *Lathyrus eucosmus* in the southeastern foothills in 1987 and *Potentilla hyparctica* near the Continental Divide in 1988. Fertig (1992) found three new species records in 1990: *Coronilla varia* and *Tanacetum parthenium* (both introduced weeds) and *Erigeron lanatus* (a rare alpine endemic). Exploration of the Arrow Mountain area on the east slope in 1996 generated first records of *Arnica angustifolia* var. *tomentosa* and *Braya humilis* by Fertig and *Helictotrichon mortonianum* by Hartman. Massatti discovered *Carex lenticularis* var. *dolia* and Massatti and Wells (2008) found *Festuca viviparoidea* ssp. *krajinae* in 2005–06. Nelson added *Muscari botryoides* from the vicinity of Atlantic City in 2005. Brasher and Enloe (2007) documented *Rorippa austriaca* from two sites near Cora along the western boundary of the study area in 2006.

Rare Species. The Wyoming Natural Diversity Database currently lists 82 species from the Wind River

Range as species of concern or potential species of concern (Heidel 2012). No plant species from the Wind Rivers are listed as Threatened or Endangered under the US Endangered Species Act (ESA), although two species were added to the Candidate list for potential listing in 2011. Whitebark pine (*Pinus albicaulis*) is a Candidate due to impacts from white pine blister rust, mountain pine beetles, and fire suppression (Ashe 2011). Small rockcress (*Boechera pusilla*), a South Pass endemic, was added to the list because of a significant population crash (Gould 2011). Of the 82 species of concern, 30 are designated Sensitive by the US Forest Service or BLM Wyoming state office (Heidel 2012). Sensitive species are given special management attention to prevent their continued downward population trends and potential listing as threatened or endangered. Most of the Sensitive species are Wyoming or Rocky Mountain endemics or arctic/boreal disjuncts and tend to occur in calcareous alpine or wetland habitats (Fertig 1997, 1998).

Richness by Vegetation Types. Of the 21 main vegetation types recognized for the Wind River Range, dry meadows have the highest species richness, with 693 taxa or 54 percent of the total flora (Table 1). Nearly as species-rich are wet meadows (572 taxa) and big sagebrush grasslands (607 taxa). Among forested vegetation types, forested wetlands have the highest species richness with 384 taxa (30 percent of the flora), followed by aspen forests with 332 taxa. Lodgepole pine forests, often considered species-poor, support a higher number of plant taxa in the Wind Rivers (324 taxa) than spruce-fir forests (263 taxa) or any other conifer-dominated vegetation type. Granite and gneiss rock outcrops have relatively high overall species richness with 409 taxa (32 percent) (Table 1).

Richness by Geographic Subregions. Fifty-four percent of the plant species of the Wind River Range (694 taxa) occur in four or less of the ten geographic subregions, with 21 percent (278 taxa) restricted to a single region (Table 1). By contrast, just 13 percent of the flora is found in nine or more subregions (168 taxa). Each subregion has at least 12 species that are not found elsewhere in the range. The Limestone Mountain (77 taxa) and Fremont Lake (65 taxa) subregions have the greatest number of such "endemics". Total species richness is highest in the Fremont Lake area with 877 taxa, representing 68 percent of the entire flora of the Wind Rivers (Table 1). This is also the largest subregion and is relatively heterogeneous in elevation and vegetation (though more uniform in geologic substrates). South Pass, one of the smallest subregions and lacking the elevational and vegetation diversity of other areas, has the lowest species richness with just 377 taxa, or 29.4 percent of the total flora.

Based on Jaccard's Index of Similarity, the average similarity between each pair of subregions is 0.428 (a score of 1.0 indicates complete similarity, and 0.0 complete dissimilarity). With the exception of the Popo Agie area, subregions at the far north and west slope of the range have higher average Jaccard's similarity than regions on the east slope or south end of the range (Table 3). Adjacent subregions tend to be more similar to each other than to more distant subregions, suggesting that environmental changes are gradual. The Boulder Creek and Fremont Lake subregions on the west slope are the most similar of any two pairs. Fertig (1992) noted the primary difference between these regions is in management history, with Fremont Lake being traditionally grazed by cattle and Boulder Creek by sheep. Massatti (2007) found that differences between the east slope and west slope subregions were less pronounced when averaged together, with a Jaccard's similarity of 0.645. The similarity between east and west slopes may be enhanced by the presence of high elevation calceophilic plants in the Green River Lakes region, which are otherwise found only on the east side.

The South Pass and Limestone Mountain subregions are the least similar to other areas of the range, with average Jaccard's similarity values of 0.318 and 0.375 respectively (Table 3). The distinctiveness of the South Pass flora can be attributed in part to floristic similarities with the adjacent high desert of the Great Divide Basin and the absence of large lakes or subalpine and alpine plant communities found in other subregions. The disparity in total species richness between South Pass and other regions can also dampen similarity scores (Fertig 1992). The relatively low elevation of the Limestone Mountain subregion, as well as its proximity to the Wind River Basin and high local endemism, are factors contributing to its distinctive flora (Massatti 2007).

Significance of the Wind River Range. The Wind River Range has the second highest number of plant taxa of any floristic region in western Wyoming (Table 4), trailing only Yellowstone National Park. This high

Table 3. Jaccard's Index of Similarity for the flora of geographic subregions of the Wind River Range. Values across the top diagonal of the table are numbers of species shared between subregions, while values across the bottom diagonal are the Jaccard's Index of Similarity scores. Jaccard's Index is determined by the formula $j = c/(N_1 + N_2 - c)$ where c = number of taxa in common between two sites and N_1 and N_2 = the number of taxa in sites 1 and 2 respectively.

	Number of Taxa in Common									
Subregion	B	D	F	G	L	M	P	S	T	W
B		383	615	374	385	402	474	288	366	390
D	0.463		446	341	255	294	410	173	332	362
F	0.649	0.467		460	419	472	503	314	417	452
G	0.449	0.484	0.490		265	323	339	178	329	339
L	0.431	0.296	0.399	0.313		311	344	261	338	292
M	0.502	0.393	0.512	0.452	0.390		325	246	307	349
P	0.587	0.577	0.519	0.436	0.408	0.413		245	364	370
S	0.372	0.237	0.334	0.247	0.369	0.380	0.337		214	201
T	0.423	0.449	0.415	0.446	0.423	0.406	0.468	0.302		323
W	0.476	0.527	0.476	0.480	0.354	0.504	0.494	0.287	0.432	
	Jaccard's Index of Similarity									

Average Jaccard's Similarity
Rangewide: 0.428
Boulder Creek drainage (B): 0.484
Dinwoody Creek drainage (D): 0.432
Fremont Lake (F): 0.473
Green River Lakes (G): 0.422
Limestone Mountain (L): 0.375
Moccasin Basin (M): 0.439
Popo Agie River drainage (P): 0.471
South Pass (S): 0.318
Torrey Lake (T): 0.418
Warm Spring Creek (W): 0.448

Table 4. Species richness of selected floras of western Wyoming.

Flora	Number of Plant Taxa	Source
Absaroka Range	1182	Evert (2010), Kirkpatrick (1987); Rosenthal (1999); Snow (1994)
Great Divide Basin	877	Welp (1997)
Green River Basin	1047	Cramer (1997)
Gros Ventre Range	863	Lichvar (1979)
Targhee National Forest	1104	Markow (1994)
Grand Teton National Park and vicinity	1056	Kesonie & Hartman (2011); Shaw (1992); Spence & Shaw (1981)
Wind River Basin	885	Haines (1988)
Wind River Range	1282	This paper
Wyoming/Salt River ranges	1087	Hartman & Nelson (RM data)
Yellowstone National Park	1340	Whipple (2000, 2001)

species richness can be attributed to several factors. The Wind Rivers are one of the largest mountainous areas in the state, and ecologists have long recognized the correlation between species richness and increasing area (Rosenzweig 1995). The broad elevational range (1725 to 4208 m), diversity of geologic substrates (Precambrian granite and gneiss, Mesozoic calcareous formations, and volcanic outcrops), and wide variety of vegetation types also contribute to landscape heterogeneity and increased species richness. The intensity with which the Wind River Range has been surveyed for over 180 years (resulting in over 28,600 voucher specimens) is also a contributing factor to the richness of its flora.

Based on an analysis by Fertig (1992), the Absaroka Range has the most similar flora to that of the Wind River Range. Both have similar vegetation and elevational range, but differ in geologic substrate (the Absarokas are primarily volcanic). Geographic proximity may explain the high floristic similarity between adjacent mountain ranges, but does not account for the disparity in species richness between the Wind River Range and bordering desert basins. Floristic diversity in the Great Divide, Green River, and Wind River basins is lower than the Wind River Range in part due to their greater aridity (which restricts the diversity of forest and wet-

land habitats) and limited elevational range which precludes alpine tundra and subalpine forest communities. Likewise, the Wind Rivers have only a subset of the high desert or grassland species prevalent in basin areas (Fertig 1992).

With nearly one-half of its area protected as Wilderness, the Wind River Range plays a significant role in the conservation of Wyoming's native flora. Nearly 76 percent of all plant species known from the Wind Rivers (968 taxa) are found within the Bridger, Fitzpatrick, or Popo Agie wilderness areas, or other formally protected lands (Kendall Warm Springs Special Interest Area, BLM Special Status plants ACEC, or The Nature Conservancy's Red Canyon Ranch Preserve) (Fertig 1995a, 1995b). Of the 265 unprotected native species, all but 20 are protected elsewhere in the state (Fertig 2011). The majority of unprotected species occur at low elevations and are often uncommon within the Winds (including one-quarter of the 82 species of concern or potential concern). Most unprotected species occur at the north end, the southeast flank, or the far southern portions of the range.

ANNOTATED CHECKLIST

The checklist is sorted by major phylogenetic groups (fern allies, ferns, gymnosperms, and angiosperms), with families and species arranged alphabetically. Family taxonomy follows the classification of the Angiosperm Phylogeny Group (2009). Species nomenclature follows the RM Plant Specimen Database (Hartman et al. 2009), which itself is based on Dorn (2001) and more recent literature. Each species entry includes the current scientific name and authority, the number of specimens known from the study area (in parentheses), codes for geographic subregions within the Wind River Range, elevation range in meters, codes for vegetation types, and selected synonyms (limited to names used in earlier theses or in Dorn 2001 that differ from the currently accepted name). All vouchers are deposited at RM unless otherwise noted. Hybrid taxa are discussed under one of the parent species. Individual codes are explained below:

Symbols preceding taxon:

* Species not native to Wyoming
● State of Wyoming noxious weed
♦ Species of conservation concern
\# Historical (not relocated since 1970)

Vegetation type:

af Aspen forest
aq Aquatic (submerged or emergent)
at Alpine tundra (includes upper timber-line)
bd Badlands
bs Big sagebrush grassland (includes shrub slopes)
df Douglas-fir forest
dm Dry meadows
ds Disturbed sites
fw Forest wetlands (includes narrowleaf cottonwood)
gr Granite or gneiss outcrops
jw Juniper woodland
lf Lodgepole pine forest
lm Limestone or calcareous outcrops
lw Limber pine woodlands
ma Marshes and bogs
rs Riparian shrub (non willow; includes silver sagebrush grassland)
sa Sand and gravel bars
sf Spruce-fir forest (includes blue spruce forests)
wm Wet meadows (forb dominated)
wf Whitebark pine forest
wt Willow thickets

Geographic regions within the study area

B Boulder Creek drainage (South Central/West)
D Dinwoody Creek Drainage (North Central/East)
F Fremont Lake (North Central/West)
G Green River Lakes
L Limestone Mountain (Southeast)
M Moccasin Basin
P Popo Agie River drainage (South Central/East)
S South Pass
T Torrey Lake (Northeast)
W Warm Spring Creek Drainage (North)

Sensitive or Candidate plant species

BLM = Bureau of Land Management
BTNF = Bridger-Teton National Forest
USFS = US Forest Service,
  R2 = Region 2 (Rocky Mountain Region)
  R4 = Region 4 (Intermountain Region)
USFWS: US Fish and Wildlife Service.

FERN ALLIES

Equisetaceae

Equisetum arvense L. (78) B, D, F, G, L, M, P, S, T, W; 2210–3500m; af, dm, ds, fw, lf, lm, ma, sa, sf, wm, wt.

Equisetum hyemale L. var. *affine* (Engelm.) A.A. Eaton (15) B, F, L, M, P, S; 1860–2925m; af, df, fw, ma, rs, sa, wt; (includes *E.* × *ferrissii*, a hybrid with *E. laevigatum*).

Equisetum laevigatum A. Braun (23) F, G, L, M, S, T, W; 1790–2670m; fw, ma, sa, wm, wt.

Equisetum variegatum Schleich. ex F. Weber & D. Mohr var. *variegatum* (14) F, G, M, W; 2290–2750m; ma, sa, wm, wt.

Isoëtaceae

Isoëtes bolanderi Engelm. var. *bolanderi* (29) B, D, F, P, W; 2225–3460m; aq, sa.

Marsileaceae

♦# *Marsilea oligospora* Goodd. (2) F; 2350m; aq; (*M. vestita* var. *oligospora*).

Selaginellaceae

Selaginella densa Rydb. (69) B, D, F, G, L, M, P, S, T, W; 2200–4050m; af, at, bs, dm, gr, lf, lm, lw, sf, wf.

♦ *Selaginella selaginoides* (L.) Link (3) F, G; 2350–2440m, wm; USFS R2 Sensitive.

FERNS

Dryopteridaceae (Aspleniaceae)

Athyrium alpestre (Hoppe) Clairv. var. *americanum* Butters (1) D; 3240–3420m; gr.

Athyrium filix-femina (L.) Roth ex Mert. (1) W; 2600–2690m; fw.

Cystopteris fragilis (L.) Bernh. (77) B, D, F, G, L, M, P, S, T, W; 2160–3960m; af, at, bs, df, dm, fw, gr, lm, lw, sa, sf, wf, wm, wt.

Woodsia oregana D.C. Eaton var. *oregana* (8) B, D, G, L, P, S, T; 1960–2860m; gr, lm.

Woodsia scopulina D.C. Eaton (14) B, D, F, L, P, T; 2250–3410m; af, df, gr, lm, sf, wf.

Ophioglossaceae

♦# *Botrychium lanceolatum* (S.G. Gmel.) Angstr. var. *lanceolatum* (1) P; 2680m; dm.

Botrychium lunaria (L.) Sw. (2) F, G; 3200–3475m; gr, lm.

Botrychium multifidum (S.G. Gmel.) Trevisan (2) B, F; 2770–2830m; fw.

Pteridaceae (Adiantaceae)

Cheilanthes feei T. Moore (4) G, L; 1850–3050m, lm.

Cryptogramma acrostichoides R. Br. (33) B, D, F, P, W; 2440–3720m; at, dm, gr, lf, sf.

♦# *Cryptogramma stelleri* (S.G. Gmel.) Prantl (1) W; 2650m, lm.

Pellaea breweri D.C. Eaton (1) L; 2330–2560m; lm.

Pellaea glabella Mett. ex Kuhn var. *occidentalis* (E.E. Nelson) Butters (6) L; 1850–2865m; lm; (*P. occidentalis*).

GYMNOSPERMS

Cupressaceae

Juniperus communis L. var. *depressa* Pursh (102) B, D, F, G, L, M, P, S, T, W; 2175–3795m; af, bs, df, dm, fw, gr, lf, lw, sf, wf, wm, wt.

Juniperus osteosperma (Torr.) Little (3) L; 1725–1915m; jw, lm, lw.

Juniperus scopulorum Sarg. (56) B, D, F, L, P, S, T; 1725–3120m; af, bs, df, dm, ds, fw, gr, jw, lf, lw, rs, sa.

Pinaceae

Abies bifolia A. Murray bis (51) B, D, F, G, L, M, P, T, W; 2430–3600m; af, at, dm, fw, gr, lf, sf, wf, wm; (*A. lasiocarpa*).

Picea engelmannii Parry ex Engelm. var. *engelmannii* (86) B, D, F, G, L, M, P, T, W; 2310–3520m; af, at, dm, fw, gr, lf, lm, lw, sf, wf, wm.

Picea glauca (Moench) Voss (1) D; 3140m; wt.

Picea pungens Engelm. (11) B, F, M, T; 2300–2590m; fw, lf, sa, sf.

♦ *Pinus albicaulis* Engelm. (56) B, D, F, G, M, P, T, W; 2530–3680m; at, bs, dm, gr, lf, sf, wf, wm; USFWS: Candidate, USFS R2 & WY BLM Sensitive.

Pinus contorta Douglas ex Loud. var. *latifolia* Engelm. (85) B, D, F, L, M, P, S, T, W; 2200–3170m; af, bs, df, dm, ds, fw, gr, lf, rs, sa, sf, wf, wm.

♦ *Pinus flexilis* E. James (59) B, D, F, G, L, M, P, S, T, W; 1725–3520m; af, bs, df, dm, gr, jw, lf, lm, lw; WY BLM Sensitive.

Pseudotsuga menziesii (Mirb.) Franco var. *glauca* (Beissn.) Franco (43) B, F, G, L, P, S, T; 1860–3520m; af, bs, df, dm, ds, gr, lf, lm, lw.

ANGIOSPERMS

Adoxaceae (Caprifoliaceae)

Sambucus racemosa L. var. *melanocarpa* (A. Gray) McMinn (16) B, D, F, G, L, T, W; 2325–3475m; bs, dm, fw, gr, wm.

Sambucus racemosa L. var. *microbotrys* (Rydb.) Kearney & Peebles (27) B, D, F, L, P, T, W; 2375–3365m; af, dm, fw, gr, lf, ma, wf.

Alismataceae

Sagittaria cuneata E. Sheld. (9) B, F, M, P; 2225–2900m; aq, wt.

Alliaceae (Liliaceae)

Allium acuminatum Hook. (8) B, D, F, G; 2255–3140m; bd, bs, lf, sf.

Allium brandegeei S. Watson (15) B, F; 2375–3600m; af, at, bd, bs, dm, fw, gr, lf, sf, wf.

Allium brevistylum S. Watson (15) B, F, G, M, P; 2300–3050m; bd, bs, fw, lf, lm, sa, wm, wt.

Allium cernuum Roth (11) D, L, T, W; 2250–3000m; bs, wt.

Allium geyeri S. Watson var. *tenerum* M. E. Jones (10) B, F, L, M, S; 2200–2745m; af, bs, dm, fw, wm.

Allium schoenoprasum L. (51) B, D, F, G, L, P, T; 2250–3535m; af, at, bs, dm, fw, gr, ma, rs, sa, sf, wm, wt.

Allium textile A. Nelson & J.F Macbr. (22) B, L, M, S, T, W; 1850–2590m; bs, df, dm, gr, wm.

Amaranthaceae (Chenopodiaceae)

Amaranthus powellii S. Watson (2) T; 1770–2255m; ds.

Atriplex truncata (Torr. ex S. Watson) A. Gray (1) S; 2350m; rs, wm.

* *Chenopodium album* L. var. *album* (2) M; 2290–2380m; ds.

Chenopodium atrovirens Rydb. (24) B, D, F, G, L, M, P, T, W; 2255–3560m; af, bs, dm, ds, lf, lm, rs, sa, wm, wt.

Chenopodium berlandieri Moq. var. *zschackei* (Murr) Murr ex Asch. (2) F, T; 2290m; ds.

Chenopodium capitatum (L.) Ambrosi var. *parvicapitatum* Welsh (24) B, F, G, M, T, W; 2290–2925m; bs, dm, ds, lf, lm, ma, sa, sf, wm; (*C. overi*).

Chenopodium fremontii S. Watson (5) T; 2290–2500m; dm.

Chenopodium leptophyllum (Moq.) Nutt. ex S. Watson (1) B; 2225m; bs.

Chenopodium pratericola Rydb. (4) B, F, G; 2225–2740m; ds, lf, lm.

* *Kochia scoparia* (L.) Schrad. (2) F; 2195–2290m; ds; (*Bassia sieversiana*, *B. scoparia*).

Krascheninnikovia lanata (Pursh) A. Meeuse & A. Smit (2) L, M; 1765–2350m; bs.

Monolepis nuttalliana (Schult.) Greene (22) B, F, M, S, T, W; 2290–2990m; af, bs, dm, ds, lf, rs, sf.

* *Salsola tragus* L. (4) B, F, S, T; 2195–2315m; bs, ds.

Anacardiaceae

Rhus trilobata Nutt. var. *trilobata* (10) L; 1700–2520m; bs, ds, jw, lm; (*R. aromatica* var. *trilobata*).

Toxicodendron rydbergii (Small ex Rydb.) Greene (5) L; 1850–2475m; bs, dm, jw.

Apiaceae

Angelica pinnata S. Watson (50) B, D, F, G, M, T, W; 2285–3790m; dm, fw, lf, ma, sa, sf, wm, wt.

Bupleurum americanum J.M. Coult. & Rose (30) G, L, M, T, W; 2260–3350m; at, bd, bs, dm, fw, lm.
* *Carum carvi* L. (3) L, P; 1890–2630m; dm, ds, wm.
Cicuta maculata L. var. *angustifolia* Hook. (1) F; 2195m; ds.
Cymopterus acaulis (Pursh) Raf. (3) L, T; 1765–2895m; bs.
Cymopterus longilobus (Rydb.) W.A. Weber (33) B, D, L, P, S, T; 1960–3815m; at, bs, df, dm, fw, gr, jw, lm, lw, sf, wf, wm.
Cymopterus longipes S. Watson (21) B, F, G, S; 2315–3415m; af, at, bs, df, dm, gr, lm.
Cymopterus nivalis S. Watson (11) T; 2330–3525m; bs, df, dm, lw.
Cymopterus terebinthinus (Hook.) Torr. & A. Gray var. *albiflorus* (Torr. & A. Gray) M.E. Jones (36) B, F, G, L, M, S, W; 1725–3500m; af, at, bd, bg, dm, ds, gr, jw, lm, lw.
Heracleum maximum Bartr. (40) B, D, F, G, L, M, P, S, T, W; 1860–3425m; af, at, bs, dm, fw, gr, rs, wm, wt; (*H. sphondylium* var. *lanatum*).
Ligusticum filicinum S. Watson (33) D, F, G, M, T, W; 2340–3350m; bs, dm, gr, lf, lm, sf, wf, wm.
Lomatium cous (S. Watson) J.M. Coult. & Rose (71) B, D, F, G, L, M, P, T, W; 2380–3840m; af, at, bs, dm, gr, lm, sf, wf, wm.
Lomatium dissectum (Nutt.) Mathias & Constance var. *multifidum* (Nutt.) Mathias & Constance (38) B, F, L, P, S, T; 1860–2925m; af, bs, dm, ds, gr, lm, lw, wm, wt.
Lomatium foeniculaceum (Nutt.) J.M. Coult. & Rose var. *foeniculaceum* (3) L, M; 2375m; bs.
Lomatium macrocarpum (Nutt. ex Torr. & Gray) J.M. Coult. & Rose (1) F; 2285m; ds.
Lomatium orientale J.M. Coult. & Rose (37) L, P, S, T; 1765–3170m; bs, dm, ds, gr.
Lomatium triternatum (Pursh) J.M. Coult. & Rose var. *platycarpum* (Torr.) Boivin (108) B, D, F, G, L, M, P, S, T, W; 1850–3170m; af, bd, bs, df, dm, ds, gr, jw, lf, lm, lw.
Musineon tenuifolium Nutt. ex Torr. & A. Gray (1) L; 1960–1990m; bs.
Orogenia linearifolia S. Watson (3) F; 2375m; af, bs.
Osmorhiza chilensis Hook. & Arn. (4) B, L; 1860–2315m; af, df, rs; (*O. berteroi*).
Osmorhiza depauperata Phil. (65) B, D, F, G, L, M, P, T, W; 2255–3500m; af, at, df, dm, ds, fw, gr, lf, sf, wm, wt.
Perideridia montana (Blank.) Dorn (34) B, F, L, M, P, S, W; 2255–2745m; bs, dm, ds, lf, rs, wm, wt.
Sium suave Walter (3) P; 2680m; aq.
Zizia aptera (A. Gray) Fernald (12) F, G, W; 2290–2470m; bs, ma, wm, wt.

Apocynaceae (Asclepiadaceae)

Apocynum androsaemifolium L. (13) B, F, L, P, T, W; 1860–2925m; af, bs, dm, fw, lf, sf.
Apocynum cannabinum L. (1) L; 1950m; bs.
Asclepias speciosa Torr. (1) F; 2375m; ds.

Araceae (Lemnaceae)

lemna minor L. (7) B, F, W; 2255–2500m; aq; (*L. turionifera*).
Lemna trisulca L. (3) F, W; 2375–2745m; aq.

Asparagaceae (Convallariaceae, Liliaceae)

maianthemum racemosum (L.) Link var. *amplexicaule* (Nutt.) Dorn (4) B, F, L; 2065–2745m; af, df, dm, lf.
Maianthemum stellatum (L.) Link (29) B, F, G, L, M, P, S, T, W; 1790–3110m; af, bs, df, dm, fw, lf, lm, rs, sa, wm, wt.

Asteraceae

achillea millefolium L. (147) B, D, F, G, L, M, P, S, T, W; 1725–3790m; af, at, bs, dm, ds, fw, gr, lf, lm, ma, sa, sf, wm, wt.
*● *Acroptilon repens* (L.) DC. (1) L; 2195m; ds; (*Centaurea repens*).
Agoseris aurantiaca (Hook.) Greene (34) B, D, F, G, M, P, W; 2315–3500m; al, bs, dm, fw, gr, lf, lm, ma, wm.
Agoseris glauca (Pursh) Raf. var. *dasycephala* (Torr. & A. Gray) Jeps. (131) B, D, F, G, L, M, P, T, W; 2065–3790m; af, at, bd, bs, df, dm, ds, fw, gr, lf, lm, lw, ma, sf, wf, wm, wt.
Agoseris glauca (Pursh) Raf. var. *glauca* (12) B, F, M, P, S; 2315–3170m; bs, dm, sf, wm, wt.
♦ *Agoseris lackschewitzii* D.M. Henderson & R. Moseley (16) B, D, F, P, W; 2760–3520m; fw, ma, wm, wt; USFS R4 Sensitive.
Agoseris parviflora (Nutt.) D. Dietrich (28) B, D, F, L, M, P, S, T, W; 2160–3710m; bs, dm, fw, jw, lw, wm; (*A. glauca* var. *laciniata*).
Anaphalis margaritacea (L.) Benth. & Hook. (18) B, D, F, M, P, W; 2440–3120m; af, dm, fw, gr, lf, sf, wm.
Antennaria anaphaloides Rydb. (30) F, G, L, M, T; 1790–3200m; af, bd, bs, df, dm, jw, lm, wm, wt.
♦ *Antennaria arcuata* Cronq. (4) F, S; 2245–2410m; dm, wm; USFS R4 & WY BLM Sensitive.
♦ *Antennaria aromatica* Evert (6) G, T; 2990–3415m; lm.
Antennaria corymbosa E.E. Nelson (81) B, D, F, M, P, T, W; 2440–3795m; at, bs, dm, fw, gr, lf, ma, rs, sf, wf, wm wt.
Antennaria dimorpha (Nutt.) Torr. (16) B, F, L, S; 2210–2635m; bs, dm, gr.
Antennaria lanata (Hook.) Greene (1) G; 2835–2895m; wm.
Antennaria media Greene (71) B, D, F, G, M, P, W; 2775–4110m; at, bs, dm, fw, gr, lm, sf, wf, wm, wt.
Antennaria microphylla Rydb. (82) B, D, F, G, L, M, P, S, T, W; 2285–3720m; at, bd, bs, df, dm, ds, gr, lf, lm, ma, rs, sa, sf, wf, wm, wt.
♦ *Antennaria monocephala* DC. ssp. *angustata* (Greene) Hulten (11) D, F, W; 2865–3960m; at, dm, gr.
Antennaria parvifolia Nutt. (12) B, F, G, L, P, T; 1850–2800m; bs, df, dm, fw, gr, lf, lw, sf, wm.
Antennaria pulcherrima (Hook.) Greene (12) F, G, L, M, W; 2290–2530m; bs, dm, ma, wm, wt.
Antennaria racemosa Hook. (26) D, F, G, M, T, W; 2440–3200m; bs, df, fw, gr, lf, sf, wm.
Antennaria rosea Greene (95) B, D, F, G, L, M, P, S, T, W; 2175–3535m; af, at, bd, bs, df, dm, ds, fw, gr, lf, lm, lw, ma, sa, sf, wf, wm.
Antennaria umbrinella Rydb. (144) B, D, F, G, L, M, P, S, T, W; 1725–3710m; af, at, bs, df, dm, ds, gr, lf, rs, sf, wf, wm, wt.
♦ *Arnica angustifolia* Vahl var. *tomentosa* (Macoun) Dorn (4) D, T; 3385–3710m; at.
Arnica chamissonis Less. (36) B, D, F, G, M, P, S, T, W; 2285–3425m; bs, dm, ds, fw, gr, lf, sa, wm, wt.
Arnica cordifolia Hook. (136) B, D, F, G, L, M, P, S, T, W; 1850–3500m; af, at, bs, df, dm, ds, fw, gr, lf, sf, wf, wm, wt.
Arnica fulgens Pursh (9) B, L, M, T; 2205–2835m; af, bs, dm, lf.
Arnica gracilis Rydb. (18) B, D, F, G, P; 2680–3720m; at, dm, gr, sf, wf.
Arnica lanceolata Nutt. ssp. *prima* (Maguire) Strother & S.J. Wolf (1) B; 2620–2800m; af, fw; (*A. amplexicaulis*).
Arnica latifolia Bong. (41) B, D, F, G, L, P, T, W; 2310–3795m; at, df, dm, fw, gr, lf, sf, wf, wm.
Arnica longifolia D.C. Eaton (20) B, D, F, G, M; 2375–3565m; bs, dm, fw, gr, lf, lm, sf, wf wm.
Arnica mollis Hook. (86) B, D, F, G, L, M, P, W; 2440–3720m; at, bs, dm, fw, gr, ma, sa, sf, wf, wm, wt; (includes *A. ovata*).
Arnica parryi A. Gray (4) F, M; 2560–3230m; dm, lf, sf, wm.
Arnica rydbergii Greene (72) B, D, F, G, L, M, P, T, W; 1960–3965m; af, at, dm, fw, gr, lf, lm, ma, sf, wm, wt.
Arnica sororia Greene (12) B, F, G, L, M; 2065–2555m; af, bs, df, dm, gr, lm.
Artemisia arbuscula Nutt. var. *arbuscula* (3) M; 2375–2590m; bs, dm.
Artemisia arbuscula Nutt. var. *longiloba* (Osterh.) Dorn (3) P, S; 2375–2615m; bs.
Artemisia biennis Willd. var. *biennis* (1) F; 2375–2410m; sa.
Artemisia campestris L. var. *pacifica* (Nutt.) M. Peck (2) F, L; 2255–2285m; bs, ds; (var. *scouleriana*).
Artemisia cana Pursh var. *cana* (1) L; 2285m; rs.

Artemisia cana Pursh var. *viscidula* Osterh. (31) F, G, L, M, S, T, W; 1725–3230m; bs, rs, wm, wt.

Artemisia dracunculus L. (18) D, F, G, M, S; 2285–3120m; af, bd, bs, dm, gr, sa, wm.

Artemisia frigida Willd. (25) D, F, L, M, P, S, T, W; 2285–3175m; bd, bs, gr.

Artemisia ludoviciana Nutt. var. *incompta* (Nutt.) Cronq. (4) D, F; 2440–3120m; gr, sa.

Artemisia ludoviciana Nutt. var. *latiloba* Nutt. (12) F, G, M, W; 2375–3410m; bs, dm, ds, lf, lm, rs, wm, wt.

Artemisia ludoviciana Nutt. var. *ludoviciana* (6) B, F, L; 1960–2375m; bs, fw, sa, wm.

Artemisia michauxiana Bess. (9) D, F, G, P, T; 2500–3230m; bs, fw, gr.

Artemisia norvegica Fries var. *saxatilis* (Bess.) Jeps. (15) D, F, G, W; 2440–3600m; at, dm, fw, gr, wf, wt.

Artemisia nova A. Nelson (2) L; 1860–1980m; jw.

Artemisia scopulorum A. Gray (70) B, D, F, G, P, T, W; 2820–4110m; at, dm, gr, sf, wm.

Artemisia tridentata Nutt. var. *tridentata* (2) F, L; 2255–2745m; bs, dm.

Artemisia tridentata Nutt. var. *vaseyana* (Rydb.) B. Boivin (47) B, D, F, G, L, M, S, T, W; 2570–2995m; af, bs, dm, ds, lf, rs, sa.

Artemisia tridentata Nutt. var. *wyomingensis* (Beetle & Young) Welsh (1) S; 2480m; bs.

Artemisia tripartita Rydb. var. *rupicola* (Beetle) Dorn (7) L, P; 1850–3170m; bs, dm, ds.

Balsamorhiza incana (Nutt.) (43) B, L, P, S, T; 1725–3170m; bs, dm, ds, gr, jw; (includes hybrids with *B. sagitatta*).

Balsamorhiza sagittata (Pursh) Nutt. (51) B, F, L, M, P, S, T, W; 1960–3295m; af, bs, dm, ds, gr, jw, lf, lw.

Brickellia grandiflora (Hook.) Nutt. (2) F; 2680–3050m; gr.

*● *Carduus nutans* L. (7) F, L; 1960–2430m; bs, ds.

* # *Centaurea scabiosa* L. (1) L; 1675m; ds.

*● *Centaurea stoebe* L. ssp. *micranthos* (S. G. Gmelin ex Gugler) Hayek (2) L; 1980m; ds; (*C. maculosa*).

Chaenactis douglasii (Hook.) Hook. & Arn. var. *alpina* A. Gray (15) D, F, G, P, S, T; 2370–3810m; at, bs, dm, gr, lm; (*C. alpina* vars. *alpina* & *leucopsis*).

Chaenactis douglasii (Hook.) Hook. & Arn. var. *douglasii* (35) B, F, L, M, P, S, T; 1725–2860m; bd, bs, dm, ds, fw, gr, jw, lw (var. *montana*).

Chrysothamnus viscidiflorus (Hook.) Nutt. var. *lanceolatus* (Nutt.) Greene (34) B, F, G, L, M, P, S, T, W; 1960–2800m; bd, bs, dm, ds, lm, rs.

Chrysothamnus viscidiflorus (Hook.) Nutt. var. *viscidiflorus* (13) B, F, M, P, S; 2195–2745m; bd, bs, ds.

* *Cichorium intybus* L. (1) B; 2560–2620m; ds.

*● *Cirsium arvense* (L.) Scop. (16) B, F, L, M, P, T; 1960–2630m; ds, fw, ma, sa, wm.

Cirsium eatonii (A. Gray) B.L. Rob. (23) D, F, G, M, P, T, W; 2680–3600m; bs, df, dm, fw, gr, lm, sf.

Cirsium hookerianum Nutt. (11) L, T; 1725–3155m; bs, dm, jw, rs.

Cirsium inamoenum (Greene) D.J. Keil var. *davisii* (Cronq.) D.J. Keil; (2) L, S; 2390–2730m; af, bs; (*C. subniveum*).

Cirsium inamoenum (Greene) D.J. Keil var. *inamoenum* (1) F; 2500–2990m; bs; (*C. subniveum*).

Cirsium pulcherrimum (Rydb.) K. Schum. var. *pulcherrimum* (6) L; 1740–2590m; bs, dm, lm .

Cirsium scariosum Nutt. var. *coloradense* (Rydb.) D.J. Keil (1) S; 2375m; ma.

Cirsium scariosum Nutt. var. *scariosum* (36) B, D, F, G, L, M, P, T, W; 2210–3230m; af, bs, dm, lf, lw, ma, sa, sf, wm, wt.

Cirsium undulatum (Nutt.) Spreng. (2) L; 1860m; bs, sa.

* *Cirsium vulgare* (Savi) Ten. (2) F; 2350–2375m; bs, sa.

Crepis acuminata Nutt. (38) B, F, G, L, M, P, S, T, W; 1725–3165m; bs, dm, ds, lm.

Crepis atribarba A. Heller (15) B, F, G, M, P, W; 2255–3110m; af, bs, dm, lf, lm, sf.

Crepis elegans Hook. (4) M, W; 2345–2795m; dm, sa.

Crepis intermedia A. Gray (1) F; 2375m bs.

Crepis modocensis Greene var. *modocensis* (22) B, F, L, M, P, S, T; 2065–2885m; bs, dm, gr.

Crepis nana Richardson (2) G; 2440–3200m; at, sa.

Crepis occidentalis Nutt. var. *costata* A. Gray (5) L; 1725–2255m; bs, ds, jw.

Crepis occidentalis Nutt. var. *occidentalis* (1) L; 1725–1915m; bs.

Crepis runcinata (E. James) Torr. & A. Gray var. *hispidulosa* Howell ex Rydb. (2) F; 2165–2410m; wm.

Crepis runcinata (E. James) Torr. & A. Gray var. *runcinata* (5) B, F, G, P; 2375–2615m; lf, ma, wm.

* *Crepis tectorum* L. (1) M; 2440–2560m; lf.

Cyclachaena xanthifolia (Nutt.) Fresen. (1) L; 1960–1980m; ds; (*Iva xanthifolia*).

Dieteria canescens (Pursh) Nutt. var. *canescens* (36) B, D, F, G, L, M, P, S, T, W; 2175–2745m; bd, bs, dm, ds, lf, lm, sa; (*Machaeranthera canescens* var. *canescens*, includes var. *monticola*).

♦ *Ericameria discoidea* (Nutt.) Nesom var. *linearis* (Rydb.) Nesom (9) G, M; 2345–2530m; bd, bs, dm, sa; (*Haplopappus macronema* var. *linearis*); USFS R4 Sensitive.

Ericameria nauseosa (Pall. ex Pursh) G.L. Nesom & G.I. Baird var. *graveolens* (Nutt.) Reveal & Schuyler (2) T; 2255m; bs; (*Chrysothamnus nauseosus* var. *graveolens*).

Ericameria nauseosa (Pall. ex Pursh) G.L. Nesom & G.I. Baird var. *nauseosa* (22) B, F, L, M, S, T; 2080–2745m; bs, dm, ds; (*Chrysothamnus nauseosus* var. *nauseosus*).

Ericameria nauseosa (Pall. ex Pursh) G.L. Nesom & G.I. Baird var. *oreophila* (A. Nelson) G.L. Nesom & G.I. Baird (2) P, S; 2480–2615m; bs; (*Chrysothamnus nauseosus* var. *oreophilus*).

Erigeron acris L. var. *kamtschaticus* (DC.) Herder (10) B, D, F, G, L, P, W; 2500–3390m; fw, gr, lm, sf, wm.

Erigeron caespitosus Nutt. (16) L, P, S, T; 1725–2900m; bs, dm, jw, lm.

Erigeron compositus Pursh (121) B, D, F, G, L, M, P, S, T, W; 1850–3960m; af, at, bd, bs, dm, ds, gr, lf, lm, lw, sa, sf, wm.

Erigeron concinnus (Hook. & Arn.) Torr. & A. Gray var. *concinnus* (5) F, M, S; 2315–2440m; bs; (*E. pumilus* var. *concinnus*).

Erigeron corymbosus Nutt. (14) B, F, L, M, P, T, W; 1725–2860m; af, bs, ds, lf, sa, wm, wt.

Erigeron divergens Torr. & A. Gray (3) B, L; 1860–2560m; bs, dm.

Erigeron eatonii A. Gray var. *eatonii* (78) B, D, F, G, L, M, P, S, T, W; 2065–3415m; af, at, bs, dm, ds, fw, gr, lf, lw, sf, wf.

Erigeron engelmannii A. Nelson var. *engelmannii* (19) B, F, L, S; 1790–2500m; bs, dm.

Erigeron formosissimus Greene var. *formosissimus* (3) B, D; 2745–3230m; dm, fw.

Erigeron formosissimus Greene var. *viscidus* (Rydb.) Cronquist (1) G; 2440–2680m; lf.

Erigeron glabellus Nutt. var. *glabellus* (10) B, F, L, M, S; 1725–2895m; bs, dm, ds, fw, sa, wt.

Erigeron glacialis (Nutt.) A. Nelson var. *glacialis* (103) B, D, F, G, L, M, P, S, T, W; 2255–3840m; at, dm, fw, gr, lf, ma, sf, wf, wm, wt; (*E. peregrinus* var. *scaposus*).

Erigeron gracilis Rydb. (27) B, F, G, M, T, W; 2285–3050m; bs, df, dm, ds, gr, lf, sf, wm.

Erigeron grandiflorus Hook. (85) B, D, F, G, M, P, T, W; 2660–4050m; at, dm, fw, gr, lm, wm, wt; (*E. simplex*).

♦ *Erigeron humilis* Grah. (3) D, F; 2950–3960m; at, dm, gr, wm.

♦ *Erigeron lanatus* Hook. (5) G; 3230–3500m; lm; USFS R4 Sensitive.

Erigeron leiomerus A. Gray (29) D, F, G, M, P, T, W; 2800–3535m; at, bs, dm, gr, lm.

Erigeron linearis (Hook.) Piper (6) B, F, S, T; 2285–3525m; bs, df.

Erigeron lonchophyllus Hook. (26) D, F, G, L, M, S, W; 2285–3050m; bs, dm, ds, gr, lf, lm, sa, wm, wt.

Erigeron nivalis Nutt. (42) B, D, F, G, L, P, T; 2255–3475m; af, bs, df, dm, fw, gr, lf, lm, ma, sa, sf, wf, wm; (*E. acris* var. *debilis*).

Erigeron ochroleucus Nutt. (30) B, D, F, G, L, M, P, S, T, W; 1725–3295m; at, bs, df, dm, fw, gr, lm, lw, sf, wm (includes vars. *ochroleucus* & *scribneri*).

Erigeron pumilus Nutt. var. *pumilus* (1) T; 2225m; bs.

Erigeron radicatus Hook. (5) G, T; 2435–3525m; at, bs, dm, lm.

Erigeron rydbergii Cronq. (9) B, L, P; 2610–4025m; dm, gr, lm.

Erigeron speciosus (Lindl.) DC. (20) B, D, F, G, M; 2315–3350m; bd, bs, dm, fw, lf, lm, mr, sa, sf, wm, wt; (includes *E. subtrinervis* var. *conspicuus*).

Erigeron tener A. Gray (3) G, S; 2285–2745m; gr, lm.

Erigeron ursinus D.C. Eaton (64) B, D, F, G, M, P, T, W; 2550–3660m; af, at, bs, dm, ds, gr, lf, lm, sf, wm, wt.

Eriophyllum lanatum (Pursh) Forbes var. *integrifolium* (Hook.) Smiley (40) D, F, G, M, W; 2315–3170m; af, bd, bs, dm, lm, sf.

Eucephalus engelmannii (D.C. Eaton) Greene (15) B, D, F, G, M, W; 2375–3230m; dm, fw, gr, lf, sf, wf; (*Aster engelmannii*).

Eucephalus perelegans (A. Nelson & J.F. Macbr.) W.A. Weber (21) B, F, G, L, M, P; 2250–3080m; af, bd, bs, df, dm, fw, lf, sa, sf; (*E. elegans*, *Aster perelegans*).

Eurybia conspicua (Lindl.) G.L. Nesom (1) M; 2440–2560m; dm; (*Aster conspicuus*).

Eurybia integrifolia (Nutt.) G.L. Nesom (28) B, D, F, M, W; 2375–3050m; bs, dm, ds, ma, rs, wm, wt; (*Aster integrifolius*).

Eurybia merita (A. Nelson) G.L. Nesom (2) M; 2440–2960m; lf, wm; (*Aster meritus*, *A. sibiricus*).

Gaillardia aristata Pursh (9) L, P; 1860–2430m; bs, df, dm.

Gnaphalium palustre Nutt. (11) B, F, M, S; 2290–2620m; bs, fw, sa, wm.

Grindelia hirsutula Hook. & Arn. (1) T; 2290m; ds; (*G. squarrosa* var. *quasiperennis*).

Grindelia squarrosa (Pursh) Dunal (4) F, L, S, T; 2255–2600m; ds; (var. *squarrosa*).

Helianthella quinquenervis (Hook.) A. Gray (25) B, D, F, G, M, P, T, W; 2440–3170m; af, bs, dm, lf, sf.

Helianthella uniflora (Nutt.) Torr. & A. Gray (16) B, F, G, M; 2255–3110m: af, bd, bs, dm, gr, lf, sa.

Helianthus annuus L. (1) L; 1960–1980m; ds.

Heliomeris multiflora Nutt. var. *multiflora* (3) F; 2380–2745m; bd, bs, sa; (*Viguiera multiflora*).

Herrickia glauca (Nutt.) Brouillet var. *glauca* (22) B, F, G, L, M, P, T; 2315–3415m; af, bd, bs, df, dm, ds, fw, gr, lm, sa, sf; (*Aster glaucodes*; *Eucephalus glaucus*).

Heterotheca depressa (Rydb.) Dorn (2) M; 2345–2380m; sa.

Heterotheca horrida (Rydb.) V.L. Harms (1) L; 1960–1990m; jw; (*H. villosa* var. *nana*).

Heterotheca villosa (Pursh) Shinners var. *villosa* (5) L; 1835–2520m; dm; (includes var. *minor*).

Hieracium albiflorum Hook. (25) B, F, G, L, M, P, W; 2335–3365m; bs, dm, fw, lf, sf, wf, wm.

Hieracium scouleri Hook. (7) B, F, L, M; 2375–3230m; bd, dm, ds, lf, sa; (includes *H. cynoglossoides*).

Hieracium triste Willd. ex Spreng. var. *gracile* (Hook.) A. Gray (58) B, D, F, M, P, W; 2530–3960m; at, dm, fw, gr, lf, sf, wf, wm; (*H. gracile*).

Hymenopappus polycephalus Osterh. (6) L, T; 1725–1915m; bs, jw.

Hymenoxys grandiflora (Torr. & A. Gray ex A. Gray) K.L. Parker (81) B, D, F, G, L, P, T, W; 2550–3960m; at, dm, gr, lm.

Hymenoxys hoopesii (A. Gray) Bierner (34) D, F, G, M, T, W; 2285–2950m; bs, dm, fw, ma, sa, wm, wt; (*Dugaldia hoopesii*, *Helenium hoopesii*).

Hymenoxys richardsonii (Hook.) Cock. var. *richardsonii* (4) L; 2600–2860m; dm.

* *Lactuca serriola* L. (8) B, F, L; 2080–2685m; af, bs, ds, sa.

*● *Leucanthemum vulgare* Lam. (2) B, F; 2620–2835m; af, ds; (*Chrysanthemum leucanthemum*).

Ligularia amplectens (A. Gray) Weber var. *holmii* (Greene) Dorn (24) D, F, G, M, W; 2800–3960m; at, dm, gr, lm; (*Senecio amplectens* var. *holmii*).

Madia glomerata Hook. (3) F, M; 2375–2440m; dm, ds.

Matricaria discoidea DC. (27) B, F, L, M, P, W; 2210–2865m; af, bs, ds, lf, wm; (*M. matricarioides*).

Microseris nutans (Hook.) Sch. Bip. (43) B, F, G, L, M, P, S; 1725–2875m; af, bs, dm, ds, gr, lf, lm, lw.

Mulgedium pulchellum (Pursh) G. Don (3) M, T; 2440–2745m; bs, wm; (*Lactuca oblongifolia*).

Nothocalais nigrescens (L.F. Hend.) A. Heller (30) B, D, F, G, L, M, P, T, W; 2375–3600m; at, bs, dm, ma, rs, sa, wm, wt.

Oreostemma alpigenum (T. & G.) Greene var. *haydenii* (Porter) Nesom (73) B, D, F, G, M, P, T, W 2500–3840m; at, bs, dm, gr, lm, sf, wf, wm, wt; (*Aster alpigenus* var. *haydenii*).

Packera cana (Hook.) W.A. Weber & Á. Löve (82) B, D, F, G, L, M, P, S, T, W; 1725–3795m; at, bd, bs, df, dm, ds, gr, jw, lm, lw; (*Senecio canus*).

Packera debilis (Nutt.) W.A. Weber & Á Löve (5) G, T; 2255–2440m; ma; (*Senecio debilis*).

Packera dimorphophylla (Greene) W.A. Weber & Á. Löve var. *paysonii* (Barkley) Trock & Barkley (5) B, G, W; 2680–3535m; lm, sf, wt; (*Senecio dimorphophyllus* var. *paysonii*).

Packera multilobata (Torr. & A. Gray ex A. Gray) Weber & Löve (11) B, F, M, S; 2315–2620m; bs, dm, gr, rs; (*Senecio multilobatus*).

Packera pauciflora (Pursh) Löve & Löve (11) B, D, F, P; 2500–3225m; dm, lf, ma, sf, wf, wm, wt; (*Senecio pauciflorus*).

Packera paupercula (Michx.) Á. Löve & D. Löve (20) B, D, F, L, M, P, S, T; 2255–2865m; bs, fw, sa, wm, wt; (*Senecio pauperculus*).

Packera streptanthifolia (Greene) W.A. Weber & Á. Löve (82) B, D, F, G, L, M, P, S, T, W; 2175–3795m; af, bd, bs, dm, ds, gr, lf, lm, ma, sf, wf, wm; (*Senecio streptanthifolius*; includes vars. *borealis*, *oodes*, and *rubricaulis*).

Packera subnuda (DC.) Trock & Barkley (53) B, D, F, P, W; 2680–3790m; at, fw, lf, ma, sa, wm, wt; (*Senecio cymbalarioides*).

Packera werneriifolia (A. Gray) W.A. Weber & Á. Löve (2) D, G; 3340–3710m; at, lm; (*Senecio werneriifolius*, includes vars. *alpinus* & *werneriifolius*).

Psilocarphus brevissimus Nutt. var. *brevissimus* (2) F; 2285m; dm.

♦ *Pyrrocoma clementis* Rydb. var. *clementis* (3) L, P; 2605–2970m; bs, dm.

♦ *Pyrrocoma integrifolia* (Porter ex A. Gray) Greene (2) L, P; 2840–2900m; dm; USFS R2 Sensitive.

Pyrrocoma uniflora (Hook.) Greene var. *uniflora* (24) B, F, L, M, P, S, W; 1725–3500m; bd, bs, dm, ds, ma, sa.

Rudbeckia occidentalis Nutt. (2) F, M: 2410–2560m; dm.

♦ *Saussurea weberi* Hult. (18) D, G, T; 2660–3535m; at, dm, lm; USFS R4 Sensitive.

Senecio crassulus A. Gray (46) B, D, F, G, M, P, T, W; 2375–3600m; af, at, dm, fw, gr, lf, lm, sf, wm, wt.

Senecio eremophilus Richardson var. *eremophilus* (2) F; 2375–2895m; bs, lf.

Senecio fremontii Torr. & A. Gray var. *fremontii* (30) B, D, F, G, P; 2725–3960m; at, dm, gr, lm, wm.

Senecio hydrophilus Nutt. (7) F, G, S; 2195–2895m; sa, wm.

Senecio integerrimus Nutt. var. *exaltatus* (Nutt.) Cronquist (168) B, D, F, G, L, M, P, S, T, W; 1790–3830m; af, at, bs, df, dm, ds, fw, gr, jw, lf, lm, ma, sa, ssf, wf, wm.

Senecio lugens Richards. (45) B, D, F, G, L, P, T, W; 2065–3840m; at, bs, dm, fw, gr, lw, sf, wm, wt.

Senecio rapifolius Nutt. (1) P; 2680m; gr.

Senecio serra Hook. var. *admirabilis* (Greene) A. Nelson (7) D, T, W; 2600–3520m; af, dm, fw, ma, wm.

Senecio serra Hook. var. *serra* (21) B, F, G, M, W; 2255–3005m; af, bs, dm, ds, fw, gr, lf, ma, wm.

Senecio sphaerocephalus Greene (38) B, D, F, G, L, M, P, W; 2315–3110m; bs, dm, ds, fw, ma, sa, wm, wt.

Senecio triangularis Hook. (59) B, D, F, G, L, M, P, T, W; 2375–3795m; af, at, bs, dm, fw, lf, ma, sa, sf, wm, wt.

Solidago lepida DC. var. *salebrosa* (Piper) Semple (19) B, F, L, M, P, S, T; 2255–2730m; af, bs, ds, lf, ma, sa, wm, wt; (*S. canadensis* var. *salebrosa*).

Solidago missouriensis Nutt. (8) L, M, S; 2285–2430m; bs, lf.

Solidago multiradiata Aiton (162) B, D, F, G, L, M, P, S, T, W; 1725–3840m; at, bd, bs, df, dm, ds, fw, gr, lf, lm, ma, sa, sf, wf, wm.

Solidago nana Nutt. (5) B, D, F, L; 2335–2985m; dm, ds.

Solidago ptarmicoides (Nees) B. Boivin (1) W; 2745–2795m; dm; (*Oligoneuron album, Unamia alba*).

Solidago simplex Kunth (3) G, M; 2285–3535m; at, bs, dm, wm, wt.

Solidago velutina DC. ssp. *sparsiflora* (A. Gray) Semple (13) B, F, G, L, S; 2315–2800m; af, bs, dm, lm, sa.

* *Sonchus arvensis* L. ssp. *uliginosus* (M. Bieb.) Nyman (6) F, L, M; 2345–2410m; ds, sa.

Stenotus acaulis (Nutt.) Nutt. (50) B, F, G, L, M, P, S, T, W; 1850–3415m; at, bs, dm, ds, gr, lm, lw; (*Haplopappus acaulis*).

Stenotus armerioides Nutt. var. *armerioides* (6) L; 1725–2230m; bs, jw, lm, lw; (*Haplopappus armerioides*).

♦ *Stephanomeria fluminea* Gottlieb (3) M; 2345–2375m; sa.

Stephanomeria runcinata Nutt. (2) L, T; 2335–2520m; bs.

Symphyotrichum ascendens (Lindl.) G.L. Nesom (34) B, D, F, G, L, M, P, S, T, W; 1960–3230m; af, bs, df, dm, ds, lf, sa, sf, wm, wt; (*Aster ascendens*).

Symphyotrichum boreale (Torr. & A. Gray) Á. Löve (2) D, F; 2375–2885m; ma, sa; (*Aster junciformis, A. borealis*).

Symphyotrichum campestre (Nutt.) G.L. Nesom (9) B, F, G, M, P, S; 2315–2865m; bs, dm, ds, fw, wm; (*Aster campestris*).

Symphyotrichum eatonii (A. Gray) G.L. Nesom (12) F, G, L, M, P, T, W; 2375–2690m; ds, fw, ma, rs, wm; (*Aster bracteolatus, A. eatonii*).

Symphyotrichum foliaceum (DC.) G.L. Nesom var. *apricum* (A. Gray) G.L. Nesom (42) B, D, F, G, P, T, W; 2500–3790m; at, bs, df, dm, gr, ma, sf, wm; (*Aster foliaceus* var. *apricus*).

Symphyotrichum foliaceum (DC.) G.L. Nesom var. *parryi* (D.C. Eaton) G.L. Nesom (29) B, D, F, G, M, W; 2285–3170m; af, dm, fw, lm, sa, sf, wm, wt; (*Aster foliaceus* var. *parryi*).

Symphyotrichum frondosum (Nutt.) Nesom (1) F; 2305m; wm; (*Aster frondosus*).

Symphyotrichum lanceolatum (Willd.) G.L. Nesom var. *hesperium* (A. Gray) G.L. Nesom (12) D, F, L, P, S, T, W; 2285–3120m; bs, fw, wm, wt; (*Aster lanceolatus* var. *hesperius*).

Symphyotrichum spathulatum (Lindl.) G.L. Nesom var. *spathulatum* (55) B, D, F, G, M, P, S, W; 2195–3160m; bd, bs, dm, fw, ma, sa, wm, wt; (*Aster occidentalis, A. spathulatus*).

* *Tanacetum parthenium* (L.) Sch. Bip (1) F; 2380–2410m: sa; (*Chrysanthemum parthenium*).

*• *Tanacetum vulgare* L. (1) F; 2380m; ds.

Taraxacum ceratophorum (Ledeb.) DC. (15) B, D, F, G, P, T; 2440–3960m; at, bs, dm, fw, gr, wm; (includes *T. eriophorum*).

* *Taraxacum erythrospermum* Andrz. ex Besser (59) B, F, G, L, M, P, S, T, W; 2260–3170m; af, bs, df, dm, ds, fw, lf, lm, sa, sf, wm, wt; (*T. laevigatum*).

* *Taraxacum officinale* Weber ex F.H. Wigg. (59) B, D, F, G, L, M, P, S, T, W: 2065–3350m; af, bs, df, dm, ds, gr, jw, lf, lm, sa, sf, wm, wt.

Taraxacum scopulorum (A. Gray) Rydb. (14) B, D, F, G, P, W; 2865–4025m; at, dm, gr.

Tetradymia canescens DC. (12) B, F, L, M, S, T; 1770–2375m; bs.

Tetraneuris acaulis (Pursh) Greene var. *acaulis* (25) L, P, T; 2260–3525m; bs, df, dm, lm, lw; (*Hymenoxys acaulis* var. *acaulis*).

Tetraneuris acaulis (Pursh) Greene var. *caespitosa* A. Nelson (4) T; 2260–3525m; bs, df; (*Hymenoxys acaulis* var. *caespitosa*).

Tetraneuris acaulis (Pursh) Greene var. *epunctata* (A. Nelson) Kartesz & Gandhi (2) L; 2710–3020m; bs, dm.

Tetraneuris torreyana (Nutt.) Greene (10) L, S; 2350–2615m; bs, dm, gr, lm; (*Hymenoxys torreyana*).

Tonestus lyallii (A. Gray) A. Nelson (44) B, D, F, G, P, T, W; 2800–3830m; at, dm, gr, sf, wm; (*Haplopappus lyallii*).

Townsendia condensata Parry ex A. Gray var. *condensata* (1) T; 2775–3050m; ds, lm.

Townsendia hookeri Beaman (3) L, T; 1765–2255m; ds, jw.

Townsendia leptotes (A. Gray) Osterh. (2) G, T; 2665–3525m; dm, lm.

Townsendia montana M.E. Jones (9) D, G, M; 2375–3415m; at, bd, dm, lm; (*T. alpigena*).

Townsendia nuttallii Dorn (1) L, M, S; 2375m; dm, lw.

Townsendia parryi D.C. Eaton (37) F, G, L, M, T; 2260–3525m; bd, bs, dm, lm, sa.

Townsendia spathulata Nutt. (14) L, P, S, T; 1765–3525m; bs, dm, gr, lm.

* *Tragopogon dubius* Scop. (30) B, D, F, G, L, M, P, T; 1725–2925m; af, bs, dm, ds, jw, lf, sa, sf, wm.

* *Tragopogon pratensis* L. (4) B, L, M, W; 1860–2440m; bs, dm, ds; (*T. lammottei*).

* *Tripleurospermum maritimum* (L.) W.D.J. Koch ssp. *maritimum* (1) F; 2410–2745m; ds; (*Matricaria maritima*).

Wyethia amplexicaulis (Nutt.) Nutt. (1) W; 2745m; dm.

Xanthisma grindelioides (Nutt.) D.R. Morgan & R.L. Hartm.var. *grindelioides* (9) L, T, W; 1725–2520m; bs, dm, jw; (*Haplopappus nuttallii, Machaeranthera grindelioides*).

Berberidaceae

Berberis repens Lindl (52) B, F, G, L, M, P, S, T; 2160–2860m; af, bs, df, dm, ds, gr, lf; (*Mahonia repens*).

Betulaceae

Alnus incana (L.) Moench var. *occidentalis* (Dippel) C.L. Hitchc. (8) L, P; 2175–2940m; af, fw, ma, sa, wm.

Betula glandulosa Michx. (46) B, D, F, G, L, M, P, S, T, W; 2315–3790m; fw, gr, ma, rs, sa, wm, wt.

Betula occidentalis Hook. (17) B, F, G, L, S, T; 1860–3050m; af, df, lm, rs, sa, wm, wt.

Boraginaceae (Hydrophyllaceae)

* *Asperugo procumbens* L. (5) L; 1725–2450m; dm, wm.

Cryptantha affinis (A. Gray) Greene (4) B, S; 2225–2560m; bs, gr.

Cryptantha ambigua (A. Gray) Greene (6) B, F, S; 2255–2590m; bs, ds, gr, sa.

Cryptantha celosioides (Eastw.) Payson (10) L, T, W; 1725–1975m; bs, jw.

Cryptantha fendleri (A. Gray) Greene (3) F, S; 2345–2410m; bs.

Cryptantha flavoculata (A. Nelson) Payson (21) B, F, L, P, S; 2285–2745m; bs, dm.

Cryptantha kelseyana Greene (1) B; 2225m; ds.

Cryptantha torreyana (A. Gray) Greene (18) B, F, S; 2255–2745m; af, bs, dm, gr.

Cryptantha watsonii (A. Gray) Greene (7) L, P, T; 1960–2885m; bs, gr, jw, lm.

*• *Cynoglossum officinale* L. (1) L; 1725–1915m; bs.

Ellisia nyctelea (L.) L. (1) L; 2195–2375m; bs.

Eritrichum nanum (Vill.) Schrad. ex Gaudin var. *elongatum* (Rydb.) Cronquist (18) B, D, G, L, P, T; 2475–4025m; at, dm, gr, lm.

Hackelia floribunda (Lehm.) I.M. Johnst. (14) F, G, M, T, W; 2345–3155m; bs, dm, sa.

Hackelia micrantha (Eastw.) J. Gentry (7) F, G, M; 2440–3050m; bs, dm, ds, lf.

Hackelia patens (Nutt.) I.M. Johnst. var. *patens* (11) B, F; 2375–2895m; bs, dm.

♦ *Hesperochiron californicus* (Benth.) Wats. (1) F; 2285m; dm.

Hesperochiron pumilus (Griseb.) Porter (1) F; 2375–2410m; bs.

Hydrophyllum capitatum Douglas ex Benth. var. *capitatum* (11) F, L, M, W; 2065–2965m; af, bd, bs, dm.

Lappula cenchrusoides A. Nelson (2) T; 2255m; bs, ds; (*L. squarrosa* var. *erecta*).

Lappula occidentalis (S. Watson) Greene var. *cupulata* (A. Gray) L.C. Higgins (1) F; 2285m; bs.

Lappula occidentalis (S. Watson) Greene var. *occidentalis* (25) B, F, G, L, S, T; 1725–2745m; bs, df, dm, ds, gr, lf, lm, rs; (*L. redowskii*).

* *Lappula squarrosa* (Retz.) Dumort var. *squarrosa* (17) B, F, M, S, T; 2255–2925m; af, bs, dm, ds, sf.

Lithospermum incisum Lehm. (6) F, L, T; 1765-2570m; bs, jw.

Lithospermum ruderale Douglas ex Lehm. (43) B, F, L, M, T, W; 1790–2905m; af, bs, df, dm, ds, jw, lf, lw.

Mertensia alpina (Torr.) G. Don (51) B, D, F, G, P, T, W; 2990–4085m; at, dm, gr, wm.

Mertensia ciliata (E. James ex Torr.) G. Don var. *ciliata* (124) B, D, F, G, L, M, P, T, W; 2345–3965m; af, at, bs, dm, fw, gr, lf, ma, sa, sf, wm, wt.

Mertensia fusiformis Greene (10) B, F, T; 2315–3535m; af, bs, dm, rs.

Mertensia oblongifolia (Nutt.) G. Don (5) L, P, T; 2065–3170m; bs, dm.

Mertensia viridis (A. Nelson) A. Nelson (63) B, F, G, L, M, P, S, T; 2150–3525m; af, at, bs, dm, ds, fw, lf, sf, wf, wm.

Myosotis alpestris F.W. Schmidt (52) D, F, G, M, T, W; 2475–3525m; af, at, bs, dm, fw, gr, lf, lm, sf, wf, wm.

* *Myosotis arvensis* (L.) Hill (1) D; 3230m; wf.

* *Myosotis scorpioides* L. (1) W; 2680–2715m; fw.

Nemophila breviflora A. Gray (18) B, F, L, M, S, W; 2375–2865m; af, bs, df, dm.

Pectocarya penicillata (Hook. & Arn.) A. DC. (1) S; 2315–2345m; bs.

Phacelia franklinii (R. Br.) A. Gray (26) D, F, G, M, W; 2380–2795m; bs, df, dm, lf, rs, wm, wt.

Phacelia hastata Douglas ex Lehm. var. *hastata* (36) B, D, F, G, L, M, P, S, T, W; 1790–3600m; bd, bs, df, dm, gr, jw, lm, wf, wm, wt.

Phacelia sericea (Graham ex Hook.) A. Gray var. *ciliosa* Rydb. (22) D, F, L, M, P, T, W; 1850–3500m; af, bs, dm, ds, gr, lf, sf, wf, wm.

Phacelia sericea (Graham ex Hook.) A. Gray var. *sericea* (90) B, D, F, G, L, M, P, S, T, W; 1860–3780m; af, at, bs, df, dm, ds, fw, gr, lf, lm, lw, ma, sa, sf, wf.

Plagiobothrys leptocladus (Greene) I.M. Johnst. (1) F; 2375m; sa.

Plagiobothrys scouleri (Hook. & Arn.) I.M. Johnst. var. *hispidulus* (Greene) Dorn (36) B, D, F, L, M, P, S, W; 2375–3140'; af, aq, bs, df, dm, ds, fw, rs, sa, wm.

Brassicaceae

* *Alyssum alyssoides* (L.) L. (8) L; 1725–2560m; bs, ds, jw, rs.

* *Alyssum desertorum* Stapf (23) B, F, L, M, S, T; 2065–2865m; af, bs, dm, ds, lf.

* *Alyssum simplex* Rudolphi (1) L; 2145m; dm; (*A. parviflorum* var. *micranthum*).

Arabis eschscholtziana Andrz. in Ledeb. (4) B, T, W; 2255–2860m; bs, fw, lm, sf; (*Arabis hirsuta* var. *glabrata*).

Arabis nuttallii B.L. Rob. (10) B, F, G, M, T; 2345–2745m; af, bs, dm, fw, lm, wm, wt; (*Boechera nuttallii*).

Arabis pycnocarpa M. Hopkins (10) F, G, L, P, T; 1860–2745m; af, bs, df, dm, fw, lm, sf; (*A. hirsuta* var. *pycnocarpa*).

Barbarea orthoceras Ledeb. (25) B, D, F, L, M, P, T; 2065–2955m; af, bs, dm, fw, gr, sa, sf, wm, wt.

* *Berteroa incana* (L.) DC. (7) B, F; 2165–2560m; ds.

Boechera collinsii (Fernald) Áskell Löve & D. Löve (7) D, F, L, S; 2375–3085m; dm, gr, lm; (*B. holboellii* var. *collinsii*, *Arabis holboellii* var. *collinsii*).

Boechera grahamii (Lehm.) Windham & Al-Shehbaz (34) B, D, F, G, L, M, P, S, W; 1790–3655m; at, bd, bs, dm, fw, gr, jw, lf, lm, sf; (*Boechera brachycarpa; Arabis confinis*; two collections appear to be hybrids with *B. holboellii* var. *secunda* according to R.C. Rollins).

Boechera languida (Rollins) Windham & Al-Shehbaz (1) S; 2315–2440m; bs; (*B. demissa* var. *languida*, *Arabis demissa*).

Boechera lemmonii (Wats.) Weber var. *lemmonii* (22) B, D, F, G, M, P, W; 3050–3830m; at, dm, gr; (*Arabis lemmonii*).

Boechera lyallii (Wats.) Dorn (36) B, D, F, M, P, W; 2500–3965m; at, dm, gr, lf, sa, sf, wf, wm; (*Arabis lyallii*).

Boechera macounii (Wats.) Windham & Al-Shehbaz (4) L, P, T; 2260–2655m; bs, wt; (*B. microphylla* var. *macounii*, *Arabis microphylla* var. *macounii*).

Boechera microphylla (Nutt.) Dorn (24) B, D, F, G, S, W; 2345–3625m; af, dm, gr, lm, lw; (*Arabis microphylla* var. *microphylla*).

Boechera pauciflora (Nutt.) Windham & Al-Shehbaz (3) B, G, T; 2225–2800m; bs, lf, lm; (*B. sparsiflora*, *Arabis sparsiflora* var. *subvillosa*).

♦ *Boechera pendulina* (Greene) W.A. Weber (14) S; 2315–2500m; bs, dm, gr; (*Arabis pendulina* var. *russeola*).

Boechera pendulocarpa (A. Nelson) Windham & Al-Shehbaz (87) B, D, F, G, L, M, P, S, T, W; 1725–3230m; af, bs, df, dm, gr, jw, lf, lm, lw, sf, wm; (*B. exilis*, *Arabis pendulocarpa*).

Boechera pinetorum (Tidestr.) Windham & Al-Shehbaz (30) B, D, F, G, L, M, P, T, W; 1790–3190m; af, bs, df, dm, fw, gr, jw, lf, lm, sa, sf; (*B. holboellii* var. *pinetorum*, *Arabis holboellii* var. *pinetorum*).

♦ *Boechera pusilla* (Rollins) Dorn (8) S; 2440m; gr; (*Arabis pusilla*); USFWS Candidate, WY BLM Sensitive.

Boechera retrofracta (Graham) Á. Löve & D. Löve (83) B, D, F, G, L, M, P, S, T, W; 1725–3500m; af, bd, bs, dm, ds, fw, gr, lf, lm, sa, sf, wf, wm; (*B. holboellii* var. *secunda*, *Arabis holboellii* var. *secunda*).

Boechera saximontana (Rollins) Windham & Al-Shehbaz (10) D, L, P, S, T, W; 1850–3500m; bs, dm, wf; (*B. williamsii* var. *saximontana*, *Arabis williamsii* var. *saximontana*).

Boechera spatifolia (Rydb.) Windham & Al-Shehbaz (1) L; 1800–1860m; lm; (*B. fendleri* var. *spatifolia*, *Arabis fendleri*).

Boechera stricta (Graham) Al-Shehbaz (147) B, D, F, G, L, M, P, S, T, W; 2255–3500m; af, at, bs, df, dm, ds, fw, gr, lf, lm, sa, sf, wf, wm, wt; (*B. angustifolia*, *Arabis drummondii*).

♦ *Boechera williamsii* (Rollins) Dorn (19) B, D, L, P; 2510–3815m; at, bs, dm, gr; (*Arabis williamsii* var. *williamsii*).

♦ *Braya humilis* (Ledeb.) Robins. (2) D, T; 3310–3730m; lm.

* *Camelina microcarpa* Andrz. ex DC (18) B, F, L, T; 1765–2620m; af, bs, ds, jw, sa.

* *Capsella bursa-pastoris* (L.) Medik (26) B, F, L, M, T, W; 1725–2865m; af, bs, dm, ds, lf, sa, wm.

Cardamine breweri S. Watson (2) F; 2050–2440m; wm.

Cardamine oligosperma Nutt. var. *oligosperma* (8) B, F, W; 2620–3050m; fw, wm, wt.

Cardamine pensylvanica Muhl. ex Willd. (22) B, D, F, G, L, M, P, S; 2210–3210m; fw, ma, wm, wt.

* *Cardaria chalepensis* (L.) Hand.-Mazz (2) T, W; 2225–2715m; bs, dm, ds.

*● *Cardaria pubescens* (Meyer) Jarmol (1) T; 2255m; af.

* *Chorispora tenella* (Pall.) DC. (8) B, F, L; 2500–2745m; af, dm, ds, lf.

Descurainia californica (A. Gray) Schulz (4) F; 2410–2990m; af, bs.

Descurainia incana (Bernh. ex Fisch. & C.A. Mey.) Dorn (66) B, D, F, G, L, M, P, S, T, W; 1725–3270m; af, bs, df, dm, ds, gr, jw, lf, lm, lw, ma, sa, sf, wf, wm, wt; (includes vars. *macrosperma* & *major*).

Descurainia incisa (Engelm.) Britton var. *incisa* (4) F, G; 2470–3535m; at, dm, lm; (*D. incana* var. *viscosa*).

Descurainia longepedicellata (E. Fourn.) O.E. Schulz. (5) L, T; 1790–2560m; bs, ds, fw, jw; (*D. pinnata* var. *filipes*).

Descurainia nelsonii (Rydb.) Al-Shehbaz & Goodson (19) B, F, L, P, S, W; 2175–2990m; af, bs, df, dm, ds, gr, lf, sf, wm; (*D. pinnata* var. *nelsonii*).

Descurainia pinnata (Walter) Britton ssp. *brachycarpa* (Richardson) Detling (2) L; 2065–2175m; dm; (includes var. *osmiarum*).

* *Descurainia sophia* (L.) Webb ex Prantl (19) B, F, L, M, S, T, W; 2210–2745m; af, bs, dm, ds, lf.

Draba albertina Greene (138) B, D, F, G, L, M, P, S, T, W; 2210–3600m; af, at, bd, bs, dm, fw, gr, lf, lw, ma, rs, sa, sf, wf, wm, wt.

Draba aurea Vahl ex Hornem. (62) B, D, F, G, M, P, T, W; 2440–3840m; af, at, dm, fw, gr, lf, lm, lw, ma, sf, wf, wm, wt.

♦ *Draba borealis* DC. (2) G; 2620m; fw, lm; BTNF Sensitive.

Draba calcifuga Lesica (1) F; 3415–3475m; gr; (included in *D. oligosperma* by some authors).

Draba cana Rydb. (27) D, F, G, L, P, T; 2375–3755m; at, bs, dm, fw, gr, lm.

♦ *Draba crassa* Rydb. (17) B, D, F, G, L, M, P, S, T, W; 3025–4055m; at, dm, gr.

Draba crassifolia Graham (49) B, D, F, G, P, W; 2865–3965m; at, dm, gr, lm, sf, wf.

Draba densifolia Nutt. (9) P, S, W; 2315–3170m; bs, dm, gr.

♦ *Draba fladnizensis* Wulf (8) D, P; 3170–4025m; at, dm, gr.

♦ *Draba globosa* Payson (11) D, F, G, P, T; 2665–3790m; at, dm, gr, lm; (*D. apiculata*); USFS R4 Sensitive.

Draba incerta Payson (28) B, D, F, G, P, W; 2800–3750m; at, dm, gr, lm.

Draba lonchocarpa Rydb. var. *lonchocarpa* (28) B, D, F, G, T; 2990–3840m; at, gr, lm.

* *Draba nemorosa* L. (23) B, F, G, L, M, P, S; 1850–2745m; af, bs, dm, ds, gr, wm.

♦ *Draba novolympica* Payson & St. John (2) T; 2665–3525m; at, dm; (*D. paysonii* var. *treleasii*).

Draba oligosperma Hook. (61) B, D, F, G, L, M, P, S, T, W; 2065–3670m; at, bd, bs, dm, jw, lm, lw.

♦ *Draba paysonii* Macbr. var. *paysonii* (8) D, F, G, W; 2865–3790m; at, dm, gr, lm.

♦ *Draba porsildii* Mulligan (9) B, F, G, T; 3230–3750m; at, gr.

Draba praealta Greene (17) B, D, F, G, M; 2345–3270m; af, bs, fw, gr, lf, lm, sf, wf, wm, wt.

Draba ventosa A. Gray (9) D, G, M, P, W; 2865–4110m; at, dm, fw, gr.

Erysimum capitatum (Douglas ex Hook.) Greene var. *capitatum* (31) D, F, L, M, S, T, W; 1790–3155m; bs, dm, jw, lf, lm, wm; (*E. asperum* var. *arkansanum*).

Erysimum cheiranthoides L. ssp. *altum* Ahti (5) F, G, M; 2375–3050m; bs, lm, rs, wm.

Erysimum inconspicuum (Wats.) MacM. (15) F, G, M, W; 2285–2745m; bs, dm, lm, rs, sa, wm, wt.

Halimolobos virgata (Nutt.) O.E. Schulz (4) T; 2225–2650m; dm, ds.

Hutchinsia procumbens (L.) Desv. (1) S; 2440–2470m; wm; (*Hornungia procumbens*).

* *Lepidium campestre* (L.) R. Br. (1) L; 1785m; ds.

Lepidium densiflorum Schrad. var. *densiflorum* (14) B, F, S; 2345–2865m; af, dm, ds, sa, wm.

Lepidium densiflorum Schrad. var. *macrocarpum* G.A. Mulligan (4) B, F; 2225–2925m; bs, ds, lf, sf, wm.

*• *Lepidium latifolium* L. (1) T; 2285m; ds.

* *Lepidium perfoliatum* L. (5) B, F, L, M; 1725–2925m; bs, ds, lf.

Lepidium ramosissimum A. Nelson var. *bourgeauanum* (Thell.) Rollins (3) S, T; 2225–2345m; bs.

Lepidium ramosissimum A. Nelson var. *ramosissimum* (18) B, F, M, T, W; 2315–2865m; bs, ds.

* *Lepidium virginicum* L. (2) B, W; 2650–2925m; ds.

Nasturtium officinale R. Br. (2) F, L; 1860–2375m; wm.

Noccaea parviflora (A. Nels.) Holub (36) B, D, F, G, M, P, S, T, W; 2410–3500m; af, bs, dm, gr, lf, rs, wf, wm; (*Thlaspi parviflorum*).

♦ *Parrya nudicaulis* (L.) Boiss. (16) D, G, P, T; 3155–3665m; at, gr, lm; USFS R4 Sensitive.

Physaria acutifolia Rydb. var. *acutifolia* (4) M, T; 2315–3110m; bd, dm, lw.

Physaria arenosa (Richardson) O'Kane & Al-Shehbaz var. *arenosa* (2) L; 1765–2390m; bs, dm; (*Lesquerella arenosa*).

Physaria didymocarpa (Hook.) A. Gray var. *didymocarpa* (3) T; 2620–2990m; dm.

♦ *Physaria fremontii* (Rollins & Shaw) O'Kane & Al-Shehbaz (33) L, S, T; 2330–3385m; bs, dm, lm; (*Lesquerella fremontii*); USFS R2 & WY BLM Sensitive.

Physaria integrifolia (Rollins) Lichvar var. *integrifolia* (5) M; 2345–2530m; bd, dm, lf.

Physaria nelsonii O'Kane & Al-Shehbaz (3) T; 3110–3535m; dm; (*Lesquerella condensata*).

♦ *Physaria paysonii* (Rollins) O'Kane & Al-Shehbaz (9) F; 2285–2500m; bs; (*Lesquerella paysonii*, *P. carinata* var. *paysonii*); USFS R4 Sensitive.

Physaria reediana O'Kane & Al-Shehbaz var. *reediana* (9) L, T; 1960–3360m; bs, dm, jw, lw; (*Lesquerella alpina*).

♦ *Physaria saximontana* Rollins var. *saximontana* (13) L, T; 1790–2520m; dm, jw; WY BLM Sensitive.

Physaria spatulata (Rydb.) Grady & O'Kane (2) L; 1800–2000m; bs, jw (*Lesquerella alpina* var. *spatulata*).

Rorippa alpina (S. Watson) Rydb. (7) B, F, G; 2375–3840m; sa, wm, wt; (*R. curvipes* var. *alpina*).

* *Rorippa austriaca* (Crantz) Bess. (2) F; 2255–2260m; ds.

♦ *Rorippa calycina* (Engelm.) Rydb. (1) L; 1970m; wm; WY BLM Sensitive.

Rorippa curvipes Greene var. *curvipes* (23) B, D, F, M, P, S; 2225–3240m; ds, ma, sa, wm, wt.

Rorippa curvipes Greene var. *integra* (Rydb.) Stuckey (13) D, F, M, W; 2375–3420m; fw, rs, wm, wt.

Rorippa curvisiliqua (Hook.) Bessey ex Britt. var. *curvisilqua* (1) L; 2605–2860m; ma.

Rorippa palustris (L.) Besser var. *elongata* Stuckey (1) B; 2500–2530m; wm.

Rorippa palustris (L.) Besser var. *fernaldiana* (Butters & Abbe) Stuckey (7) B, F, P; 2255–3110m; aq, dm, fw, sa, sf, wm.

Rorippa palustris (L.) Besser var. *hispida* (Desv.) Rydb. (1) F; 2285m; ds.

* *Sisymbrium altissimum* L. (5) F, L; 1790–2345m; bs, ds, jw.

Sisymbrium linifolium Nutt. (6) B, F, M, S; 2285–2560m; bs, lf; (*Schoenocrambe linifolia*).

* *Sisymbrium loeselii* L. (2) F, S; 2195m; ds.

Smelowskia calycina (Steph. ex Willd.) C.A. Mey. var. *americana* (Regel & Herd.) Drury & Roll. (55) B, D, F, G, P, T, W; 2635–3965m; at, dm, gr, lm, wm, wt.

Subularia aquatica L. (6) B, D, F, M, P; 2440–3120m; aq.

Thelypodium paniculatum A. Nelson (5) F, G, S, W; 2700–2790m; wm, wt.

* *Thlaspi arvense* L. (30) B, F, L, M, T, W; 2315–2745m; bs, ds, wm, wt.

Turritis glabra L. (33) B, D, F, G, L, M, P, S, W; 1850–3160m; af, bs, ds, fw, gr, lf, lm, sa, wm, wt; (*Arabis glabra*).

Cactaceae

Opuntia polyacantha Haw. var. *polyacantha* (8) B, F, L, S, T; 1725–2745m; bs, gr.

Pediocactus simpsonii (Engelm.) Britton & Rose (1) S; 2315–2440m; bs.

Campanulaceae

Campanula rotundifolia L. (91) B, D, F, G, L, M, P, S, T, W; 2175–3840m; af, at, bs, df, dm, fw, gr, lf, lm, sa, sf, wm.

Campanula uniflora L. (15) D, F, P, T; 2980–4110m; at, dm, gr.

Caprifoliaceae (Linnaeaceae, Valerianaceae)

linnaea borealis L. var. *longiflora* Torr. (9) B, F, G; 2255–2680m; df, fw, lf, sf.

Lonicera involucrata (Richardson) Banks ex Spreng. var. *involucrata* (52) B, D, F, L, M, P, S, T, W; 2175–3320m; af, fw, gr, rs, sa, sf, wm, wt.

* *Lonicera tatarica* L. (1) F; 2190m; af.

Lonicera utahensis Wats. (1) W; 2680–2690m; fw.

Symphoricarpos occidentalis Hook. (1) L; 2195m; df.

Symphoricarpos oreophilus A. Gray var. *utahensis* (Rydb.) A. Nelson (35) B, F, G, L, M, P, T, W; 2210–3050m; af, bs, df, dm, gr, lf, lm, lw, rs, wm, wt.

Valeriana acutiloba Rydb. var. *pubicarpa* (Rydb.) Cronq. (4) F, G; 2990–3600m; at, gr, lm.

Valeriana edulis Nutt. ex Torr. & A. Gray var. *edulis* (51) D, F, G, L, M, P, S, T, W; 2290–3525m; af, at, bs, dm, fw, lm, ma, wm, wt.

Valeriana occidentalis A. Heller (32) D, F, G, M, T, W; 2315–3170m; af, bs, dm, fw, lm, sf, wm, wt.

Caryophyllaceae

Cerastium arvense L. (52) B, D, F, G, L, M, P, T, W; 1725–3720m; at, bs, df, dm, ds, fw, gr, jw, lm, sa, wm, wt.

Cerastium beeringianum Cham. & Schlecht. var. *capillare* Fern. & Wieg. (70) B, D, F, G, M, P, T, W; 2375–4110m; at, bs, dm, fw, gr, lm, sa, wm, wt.

Cerastium brachypodum (Engelm. ex A. Gray) Robins. (3) B, L; 1960–2560m; dm, wm.

* *Cerastium fontanum* Baumg. ssp. *vulgare* (Hartm.) Greuter & Burdet (11) B, F, M, P, W; 2255–3190m; af, df, dm, lf, wm.

Cerastium nutans Raf. var. *nutans* (1) W; 2785–2950m; wt.

Eremogone congesta (Nutt.) Ikonn. var. *congesta* (156) B, D, F, G, L, M, P, S, T, W; 1850–3790m; af, at, bs, dm, ds, fw, gr, lf, lm, sf, wf, wm; (*Arenaria congesta* var. *congesta*).

Eremogone congesta (Nutt.) Ikonn. var. *lithophila* (Rydb.) Dorn (2) P, T; 2555–2905m; dm.

Eremogone hookeri (Nutt.) W.A. Weber var. *hookeri* (17) B, L, S, T, W; 1725–2485m; bs, dm, ds, jw; (*Arenaria hookeri* var. *hookeri*).

Eremogone hookeri (Nutt.) W.A. Weber var. *pinetorum* (A. Nelson) Dorn (2) L; 1860m; jw; (*Arenaria hookeri* var. *pinetorum*).

* *Gypsophila paniculata* L. (1) F; 2225m; ds.

Minuartia austromontana S.J. Wolf & Packer (10) G, T; 3230–3535m; at, dm, lm.

Minuartia nuttallii (Pax) Briq. var. *nuttallii* (23) B, G, L, T; 1790–3525m; at, bs, dm, jw, lm.

Minuartia obtusiloba (Rydb.) House (108) B, D, F, G, L, P, T, W; 2345–4110m; at, dm, gr, lf, lm, sa, wm.

Minuartia rubella (Wahlenb.) Hiern (33) B, D, F, G, L, T; 2255–3830m; at, dm, ds, gr, jw, lm, sa.

Moehringia lateriflora (L.) Fenzl (13) B, F, G, L, M, P, S; 2210–2865m; af, dm, lf, wm, wt.

Paronychia sessiliflora Nutt. (2) L, S; 2065–2410m; bs, dm.

Sagina saginoides (L.) H. Karst (55) B, D, F, G, L, M, P, S; 2210–4025m; at, df, dm, fw, gr, lf, lm, sa, wm, wt.

Silene acaulis (L.) Jacq. (62) B, D, F, G, P, T, W; 2665–4025m; at, dm, gr, lm.

Silene drummondii Hook. var. *drummondii* (15) B, D, F, M, S, T, W ; 2375–3600m; at, bs, dm, ds, fw, gr, lf, sa, sf, wm.

Silene drummondii Hook. var. *striata* (Rydb.) Bocquet (44) B, D, F, G, L, M, P, W; 2440–3600m; at, bs, dm, gr, lf, sf, wf, wm.

Silene hitchguirei Bocq. (3) D, F, P; 2975–3795m; dm, gr, lm.

Silene kingii (Wats.) Bocq. (11) D, P, T; 3240–3420m; dm.

* *Silene latifolia* Poir. (5) B, F, L, M; 1860–2620m; ds, sa, wm.

Silene menziesii Hook. (17) B, F, G, L, M; 1725–3050m; af, bs, df, ds, fw, gr, rs, sa, sf, wm.

Silene parryi (S. Watson) C.L. Hitchc. & Maguire (16) B, D, F, G, M, P, T, W; 2470–3600m; at, dm, lm.

* *Spergularia rubra* (L.) J. Presl & C. Presl (19) B, F, L, M, S, W; 2210–3170m; af, bs, dm, ds, lf, wm.

Stellaria borealis Bigelow var. *borealis* (18) B, F, G, M, T; 2255–3155m; af, df, fw, lf, lm, sf, wm; (hybridizes with *S. longifolia, WF 11359*).

Stellaria calycantha (Ledeb.) Bong. (5) B, F, L, W; 2605–3230m; lm, wm.

Stellaria crassifolia Ehrh. (4) F, S, W; 2375–3230m; wm.

Stellaria longifolia Muhl. ex Willd. (3) D, L, T; 2605–2995m; lf, ma.

Stellaria longipes Goldie var. *longipes* (120) B, D, F, G, L, M, P, S, T, W; 2210–3790m; af, at, bs, dm, ds, fw, gr, lf, lm, ma, sa, wm, wt; (includes *S. monantha*).

Stellaria obtusa Engelm. (2) F, M; 2440–2560m; dm, lf.

Stellaria umbellata Turcz. (61) B, D, F, G, M, P, W; 2410–3655m; af, at, bs, dm, fw, gr, lf, lm, ma, sf, wf, wm, wt.

Celastraceae

Paxistima myrsinites (Pursh) Raf. (17) B, F, G, L, P; 2175–2990m; af, bs, df, lf, sf, wf.

Ceratophyllaceae

Ceratophyllum demersum L. (1) B; 2440m; aq.

Clusiaceae (Hypericaceae)

Hypericum scouleri Hook. (3) F, P; 2375–3055m; ma, wt; (*H. formosum* var. *scouleri*).

Colchicaceae (Calochortaceae, Liliaceae)

Streptopus amplexifolius (L.) DC. (25) B, D, F, L, P, W; 2255–3210m; fw, lf, ma, sf, wm, wt.

Cornaceae

Cornus sericea L. var. *sericea* (26) B, F, G, L, P, S, T, W; 1860–3050m; af, bs, dm, fw, rs, sa, wm, wt.

Crassulaceae

♦ *Crassula aquatica* (L.) Schönl. (1) D; 2195m; aq; (C. solieri, Tillaea aquatica).

Sedum integrifolium (Raf.) A. Nelson (41) B, D, F, G, P, T, W; 2665–3830m; at, gr, ma, wm, wt.

Sedum lanceolatum Torr. (112) B, D, F, M, P, S, T, W; 1790–4110m; at, bs, df, dm, ds, fw, gr, jw, lf, lm, sa, sf, wf, wm.

Sedum rhodanthum A. Gray (69) B, D, F, G, L, M, P, S, T, W; 2375–3795m; at, dm, fw, gr, ma, sa, wm, wt.

Cyperaceae

Carex albonigra Mack. (23) B, D, G, P, T, W; 2485–3830m; at, dm, fw, gr, ma, sf, wf, wm.

Carex aquatilis Wahlenb. var. *aquatilis* (86) B, D, F, G, L, M, P, S, T, W; 2210–3795m; at, fw, gr, ma, sa, wm, wt.

Carex athrostachya Olney (20) B, F, M, S; 2225–2895m; dm, fw, sa, wm, wt.

Carex aurea Nutt. (31) B, D, F, G, L, M, P, T; 2260–3420m; af, fw, lm, ma, sa, wm, wt.

Carex breweri Boott var. *paddoensis* (Suksd.) Cronq. (20) D, F, G, P; 3025–3830m; at, dm, gr, lm, wm.

Carex brunnescens (Pers.) Poir. var. *brunnescens*, (10) B, D, F, P, T; 2735–3160m; fw, ma, sa, wm, wt.

Carex buxbaumii Wahl. (2) D; 2935–3175m; ma, wm.

Carex canescens L. var. *canescens* (38) B, D, F, L, P, T, W; 2255–3325m; fw, ma, sa, wm, wt.

Carex capillaris L. (13) D, F, G, P, W; 2440–3790m; ma, wm, wt.

Carex capitata L. (15) B, D, P, W; 2865–3795m; at, dm, fw, gr, ma, wm, wt.

Carex chalciolepis T. Holm (10) B, D, F, P, T; 2840–3670m; at, dm, ma, wm, wt; (*C. atrata* var. *chalciolepis*).

♦ *Carex concinna* R. Br. (2) G; 2440m; fw.

Carex disperma Dewey (30) B, D, F, G, L, M, P, T, W; 2175–3365m; af, fw, ma, sa, wm, wt.

Carex douglasii Boott (28) B, F, G, L, M, P, S, W; 1725–2895m; bs, dm, ds, sa, wm.

Carex duriuscula C.A. Mey. (7) F, L, P, T; 2375–3360m; bs, dm, wm; (*C. stenophylla*).

Carex ebenea Rydb. (2) B, P; 2590–2745m; gr, wm.

Carex elynoides Holm (66) B, D, F, G, P, T, W; 2800–3720m; at, dm, gr, lm, wm, wt.

Carex epapillosa Mack. (34) B, D, F, P, W; 2440–3600m; at, dm, fw, gr, sa, wf, wm, wt; (*C. atrata* var. *erecta*).

Carex filifolia Nutt. (11) B, L, T; 1725–2875m; bs, df, dm, jw.

♦ *Carex fuliginosa* Schkuhr ssp. *misandra* (R. Brown) Nyman (11) D, T, W; 2865–3830m; dm, ma, wm; (*C. misandra*).

Carex geyeri Boott (8) B, F, L, P; 2210–2895m; af, df, ds, lf, lm, wm.

Carex gynocrates Wormsk. ex Drejer (6) D, F, G, W; 2440–3790m; fw, ma, wm.

Carex haydeniana Olney (41) B, D, F, G, M, P, T, W; 2620–3790m; at, dm, fw, gr, ma, sa, wm, wt.

Carex hoodii Boott (42) B, D, F, G, L, M, P, T, W; 1850–3110m; af, bs, df, dm, ds, fw, gr, lf, rs, sf, wf, wm.

Carex illota L.H. Bailey (40) B, D, F, P, S, W; 2440–3795m; at, dm, fw, ma, sa, wm, wt.

♦ *Carex incurviformis* Mack. var. *danaensis* (Stacey) Hermann (4) D, F, G, T; 3415–3730m; dm, wm; USFS R4 Sensitive.

Carex interior L.H. Bailey (3) G, L, W; 2470–2800m; wm, wt.

Carex jonesii L.H. Bailey (1) F; 2590m; dm.

Carex lachenalii Schkuhr. (12) D, F; 2775–3965m; at, gr, wm, wt; (*C. bipartita*).

♦ *Carex lenticularis* Michx. var. *dolia* (Jones) Standley (1) D; 3340m; sa.

Carex lenticularis Michx. var. *pallida* (Boott) Dorn (11) B, D, F; 2225–3150m; fw, rs, sa, wm, wt.

Carex leporinella Mack. (14) B, D, F, G, P; 2590–3535m; at, bs, dm, gr, lm, sa, wm.

Carex limosa L. (4) B, D, P; 2840–3175m; ma, wm.

♦ *Carex livida* (Wahl.) Willd. (6) P; 2800–3500m; ma, wm; USFS R2 Sensitive.

♦ *Carex luzulina* Olney var. *atropurpurea* Dorn (16) B, D, F, P; 2990–3500m; dm, gr, ma, wf, wm; USFS R4 Sensitive.

Carex macloviana d'Urv (50) B, D, F, G, M, P, T, W; 2315–3790m; at, dm, fw, gr, lm, ma, sa, sf, wf, wm, wt.

♦ *Carex microglochin* Wahl. (11) D, F, P, T; 2375–4025m; ma, sa.

Carex microptera Mack. var. *limnophila* (F.J. Herm.) Dorn (16) B, D, F, L, P, S, T, W; 2210–2800m; fw, wm, wt.

Carex microptera Mack. var. *microptera* (61) B, D, F, G, L, M, P, T, W; 1860–3350m; af, at, bs, dm, fw, gr, lf, ma, rs, sa, sf, wm, wt.

Carex nardina Fries (12) B, D, F, G, P, W; 2865–4025m; at, dm, gr, lm, ma, wm.

Carex nebrascensis Dewey (18) B, D, F, G, L, P, S, T, W; 1725–2520m; af, fw, ma, sa, wm, wt.

♦ *Carex nelsonii* Mack. (11) D, P, T, W; 2865–4110m; dm, ma, wm.

Carex neurophora Mack. (3) F, P, W; 2680–3015m; fw, lf.

Carex nigricans C.A. Mey. (36) B, D, F, P, W; 2840–3795m; at, dm, fw, gr, sf, wm, wt.

Carex nova L.H. Bailey var. *pelocarpa* (F.J. Herm.) Dorn (53) B, D, F, G, P, T, W; 2865–3965m; at, dm, gr, lm, ma, wm, wt.

Carex obtusata Lilj. (3) F, W; 2470–2815m; dm, wm.

Carex pachystachya Cham. ex Steud. (6) B, F, G; 2375–3050m; dm, fw, lm, wm.

Carex paupercula Michx. (1) P; 3025–3225m; ma.

Carex paysonis Clokey (70) B, D, F, G, M, P, W; 2760–3870m; at, dm, fw, gr, ma, wm.

Carex pellita Muhl. ex Willd. (19) B, F, G, L, M, P, S, T, W; 2175–2575m; af, fw, sa, wm, wt; (*C. lanuginosa*).

Carex petasata Dewey (3) B, T; 2375–2620m; bs, sf.

Carex phaeocephala Piper (93) B, D, F, G, L, P, T, W; 2635–3830m; at, bs, dm, fw, gr, lm, sf, wf, wm.

Carex praeceptorum Mack. (15) B, D, F, P; 2680–3295m; fw, ma, wm, wt.

Carex praegracilis W. Boott (7) F, M, S; 2375–2715m; bs, dm, wm.

Carex praticola Rydb. (28) B, D, F, G, L, M, P, T, W; 2345–3235m; bs, dm, fw, gr, lf, sf, wm; (includes *C. platylepis*).

Carex pyrenaica Wahlenb. (25) B, D, F, G, P, W; 2865–3965m; at, dm, gr, wm, wt.

Carex raynoldsii Dewey (80) B, D, F, G, L, M, P, T, W; 2325–3625m; af, at, bs, df, dm, fw, gr, lf, ma, sf, wm, wt.

Carex rossii Boott (113) B, D, F, G, L, M, P, S, T, W; 1790–3445m; af, bs, df, dm, ds, fw, gr, jw, lf, lm, rs, sf, wf, wm.

Carex rupestris All. (5) D, G, P, T; 3175–3535m; at, dm, lm.

Carex saxatilis L. (36) B, D, F, G, P; 2485–3420m; af, aq, fw, ma, wm, wt.

Carex scirpoidea Michx. var. *pseudoscirpoidea* (Rydb.) Cronq. (70) B, D, F, G, P, T, W; 2935–4110m; at, dm, gr, wf, wm.

Carex scirpoidea Michx. var. *scirpoidea* (1) P; 2925m; wt.

Carex scopulorum T. Holm var. *scopulorum* (75) B, D, F, M, P, T, W; 2560–3830m; at, dm, fw, gr, lf, ma, wm, wt.

Carex simulata Mack. (17) B, F, P, T, W; 2375–2900m; ma, wm.

Carex spectabilis Dewey (3) D, F, P; 2990–4025m; dm, wm.

Carex stenoptila F.J. Herm. (16) B, D, P, T, W; 2680–3455m; af, at, dm, fw, gr, ma, wm, wt.

Carex stevenii (T. Holm) Kalela (28) B, D, F, G, L, M, P, T, W; 2530–3790m; dm, fw, ma, wm, wt; (*C. norvegica* var. *stevenii*).

Carex subnigricans Stacey (8) B, F, G, P, W; 2835–3810m; at, dm, gr, wm.

Carex tenera Dewey (1) F; 2315m; fw.

Carex utriculata Boott (84) B, D, F, G, L, M, P, S, T, W; 1960–3330m; aq, fw, lf, ma, sa, wm, wt; (*C. rostrata*).

Carex vallicola Dewey (42) B, F, L, M, P, S, T, W; 1850–2865m; af, bs, dm, ds, gr, lw, wm, wt.

Carex vernacula L.H. Bailey (1) F; 2835m; wm; (*C. foetida* var. *vernacula*).

Carex vesicaria L. (23) B, F, M, P, W; 2225–3050m; fw, ma, sa, wm, wt.

Carex viridula Michx. (2) F; 2315m; sa; (*C. oederi*).

Carex xerantica Bailey (7) L, P, W; 1850–2860m; bs, dm, ds; (*C. tahoensis*).

Eleocharis acicularis (L.) Roem. & Schult. (12) B, D, F, P; 2375–3120m; aq, sa, wm, wt.

Eleocharis palustris (L.) Roem. & Schult. (25) B, D, F, L, P, S; 2225–3120m; aq, ma, sa, wm, wt.

Eleocharis quinqueflora (Hartm.) O. Schwarz (14) B, D, P, W; 2840–3500m; aq, ma, sa, wm, wt; (*E. pauciflora*).

Eleocharis rostellata (Torrey) Torrey (1) F; 2345m; wm.

Eriophorum angustifolium Honck. (5) D, P; 2840–2970m; ma, sa, wm; (*E. polystachion*).

♦ *Eriophorum callitrix* Cham. ex Meyer (4) D, P, T; 3110–3430m; gr, wm, wt.

♦ *Eriophorum chamissonis* Meyer (1) D; 2930–2985m; sa; USFS R2 Sensitive.

♦ *Eriophorum scheuchzeri* Hoppe (11) D, F, P; 3050–3350m; wm.

Kobresia myosuroides (Vill.) Fiori & Paol. (12) D, G, T, W; 2865–3790m; at, dm, wm.

♦ *Kobresia simpliciuscula* (Wahl.) Mack. (1) D; 3130m; ma; USFS R2 Sensitive.

Schoenoplectus acutus (Muhl. ex Bigelow) Löve & Löve *var. occidentalis* (Wats.) Smith (1) F; 2440m; aq; (*Scirpus acutus*).

Schoenoplectus tabernaemontani (Gmelin) Palla (1) F; 2375–2440m; wm; (*Scirpus validus*).

Elaeagnaceae

Elaeagnus commutata Bernh. ex Rydb. (13) B, F, G, L, M, T, W; 1725–2590m; af, bd, fw, gr, rs, sa.

Shepherdia canadensis (L.) Nutt. (80) B, D, F, G, L, M, P, S, T, W; 2065–3240m; af, bd, bs, df, dm, fw, gr, lf, lw, sa, sf, wf, wm, wt.

Elatinaceae

Elatine rubella Rydb. (2) B, F; 2225–2345m; aq; (*E. triandra*).

Ericaceae

Arctostaphylos uva-ursi (L.) Spreng. (55) B, D, F, G, L, M, P, S, T, W; 2285–3200m; af, bd, bs, df, dm, gr, lf, lw, sa, sf, wf, wm, wt; (includes vars. *stipitata* and *uva-ursi*).

Chimaphila umbellata (L.) W.P.C. Barton var. *occidentalis* (Rydb.) S.F. Blake (2) L, P; 2605–2860m; lf.

Gaultheria humifusa (Graham) Rydb. (8) B, D, F, W; 2530–3240m; lf, ma, sf, wf.

Kalmia microphylla (Hook.) A. Heller (29) B, D, F, P, W; 2680–3795m; at, fw, ma, sf, wm.

Ledum glandulosum Nutt. var. *glandulosum* (6) D, P, W; 2575–3120m; fw; (*Rhododendron columbianum*).

Menziesia ferruginea Smith (1) W; 2680–2690m; fw.

Moneses uniflora (L.) A. Gray (8) D, F, G, M, T; 2440–3160m; fw, lf, ma, sf.

Monotropa hypopitys L. (2) D, W; 2600–2985m; fw; (*Hypopitys monotropa*).

Orthilia secunda (L.) House (43) B, D, F, G, L, M, P, S, T, W; 2255–3230m; af, fw, gr, lf, sf, wf, wt.

Phyllodoce empetriformis (Sw.) D. Don (44) B, D, F, P, W; 2680–3840m; at, dm, fw, ma, wm, wt.

Pterospora andromedea Nutt. (4) B, L; 2255–2725m; df, lf.

Pyrola asarifolia Michx. var. *asarifolia* (18) B, F, G, L, M, P, T, W; 2175–3200m; af, fw, lf, ma, sf, wm, wt.

Pyrola chlorantha Sw. (9) B, F, G, L, P; 2440–3050m; fw, lf.

Pyrola minor L. (11) B, D, F, M, T; 2255–3170m; fw, lf, sf, wm.

Vaccinium membranaceum Dougl. ex Torrey (1) W; 2680–2690m; fw.

Vaccinium occidentale Gray (37) B, D, F, P; 2560–3500m; fw, lf, ma, wf, wm, wt.

Vaccinium scoparium Leiberg ex Coville (84) B, D, F, L, M, P, T, W; 2440–3565m; af, at, bs, df, dm, fw, gr, lf, ma, sa, sf, wf, wm, wt.

Euphorbiaceae

Euphorbia brachycera Engelm. (2) L; 2065–2175m; dm.

*● *Euphorbia esula* L. var. *uralensis* (Fisch. ex Link) Dorn (9) L; 1725–2490m; bs, df, jw, rs, wt.

Fabaceae

Astragalus adsurgens Pall. var. *robustior* Hook. (3) T; 2165–2590m; bs, ds; (*A. laxmannii* var. *robustior*).

Astragalus agrestis Douglas ex G. Don (29) B, F, G, L, M, P, S, T, W; 1860–2990m; af, bd, bs, df, dm, ds, lf, rs, wm, wt.

Astragalus alpinus L. var. *alpinus* (99) B, D, F, G, M, P, T, W; 2345–3965m; af, at, bd, bs, dm, ds, fw, gr, lf, ma, rs, sa, sf, wf, wm, wt.

Astragalus argophyllus Nutt. var. *argophyllus* (21) B, F, L, S, W; 1725–2590m; bs, dm, ds, wm, wt.

Astragalus australis (L.) Lam. var. *glabriusculus* (Hook.) Isely (7) D, F, G; 2680–3755m; at, dm, lm.

Astragalus bisulcatus (Hook.) A. Gray var. *bisulcatus* (5) L, M, W; 1725–2560m; bd, bs, wt.

Astragalus bodinii E. Sheld. (3) B, F, S; 2195–2440m; wm.

Astragalus canadensis L. var. *brevidens* (Gand.) Barneby (10) B, F, M; 2195–2440m; af, df, dm, wt.

Astragalus chamaeleuce A. Gray (1) L; 1765–1830m; lm.

Astragalus cibarius Sheld. (1) B; 2285–2410m; bs.

Astragalus convallarius Greene var. *convallarius* (6) B, F, L; 1725–2410m; bs, jw; (mistakenly cited as *A. diversifolius* by Fertig 1992).

Astragalus drummondii Douglas ex Hook. (11) L, T; 1725–2510m; bs, dm, ds, jw.

Astragalus eucosmus B.L. Robins. (20) B, D, F, G, L, M, P, S, T; 2210–3160m; bs, fw, lf, lm, ma, sa, wm.

Astragalus flavus Nutt. (1) B; 2410m; sa.

♦ *Astragalus gilviflorus* Sheld. var. *purpureus* Dorn (2) T; 2345–2390m; bs; WY BLM Sensitive.

Astragalus kentrophyta A. Gray var. *jessiae* (Peck) Barneby (1) S; 2285m; bs.

Astragalus kentrophyta A. Gray var. *tegetarius* (Wats.) Dorn (79) B, D, F, G, L, M, P, S, T, W; 1960–3815m; at, bd, bs, df, dm, ds, gr, jw, lm, lw, sa, sf, wm.

Astragalus miser Douglas var. *decumbens* (Nutt. ex T. & G.) Cronq. (61) B, D, F, L, M, P, S, T, W; 2255–2895m; bd, bs, dm.

Astragalus miser Douglas var. *hylophilus* (Rydb.) Barneby (60) B, D, F, G, L, M, P, T, W; 1725–3525m; af, at, bs, df, dm, fw, jw, lf, lm, sa, sf, wm.

Astragalus miser Douglas var. *praeteritus* Barneby (2) F, M; 2440–2560m; bd, dm.

Astragalus missouriensis Nutt. var. *missouriensis* (2) L; 1765–1860m; bs.

Astragalus purshii Douglas ex Hook. var. *purshii* (20) B, F, L, P, S, T; 1860–2625m; bs, dm.

♦ *Astragalus shultziorum* Barneby (1) G; 3505m; lm (*A. molybdenus* var. *shultziorum*).

Astragalus spatulatus E. Sheld. (2) S; 2285–2330m; bs, dm.

Astragalus tenellus Pursh (2) M; 2315–2500m; lw.

* *Caragana arborescens* Lam. (1) F; 2255m; ds.

* *Coronilla varia* L. (1) F; 2375m; wm.

Glycyrrhiza lepidota Pursh (3) L, T; 1725–2255m; rs, wt; (includes vars. *glutinosa* & *lepidota*).

Hedysarum alpinum L. var. *philoscia* (A. Nels.) Rollins (15) D, F, L, M, P, T, W; 2375–3525m; bs, df, dm, lf, wf, wm; (var. *americanum*).

Hedysarum boreale Nutt. var. *boreale* (2) L; 1860–2175m; bs, dm.

Hedysarum boreale Nutt. var. *pabulare* (A. Nelson) Dorn (3) L; 1765–1990m; bs, jw.

Hedysarum occidentale Greene (35) B, D, F, G, L, M, P, T; 2255–3350m; af, bs, df, dm, fw, gr, lf, lm, lw, sf, wf, wm.

♦ *Lathyrus eucosmus* Butters & St. John (1) L; 1840m; ds.

Lupinus argenteus Pursh var. *argenteus* (59) B, D, F, G, L, M, P, S, T, W; 1725–3535m; af, at, bs, df, dm, ds, gr, sf, wf, wm, wt.

Lupinus argenteus Pursh var. *argophyllus* (A. Gray) S. Watson (62) B, D, F, G, L, M, P, S, W; 2065–3200m; af, bs, dm, ds, fw, gr, lf, sa, sf, wm, wt.

Lupinus argenteus Pursh var. *depressus* (Rydb.) C.L. Hitchc. (11) B, G, L, P, T, W; 2665–3535m; at, dm, ds, sf.

Lupinus argenteus Pursh var. *laxiflorus* (Douglas ex Lindl.) Dorn (5) G, M, W; 2440–2620m; bd, bs, dm.

Lupinus argenteus Pursh var. *rubricaulis* (Greene) S.L. Welsh (26) B, D, F, G, M, S, W; 2375–3230m; af, bs, dm, fw, lf, sa, sf.

Lupinus lepidus Douglas ex Lindl. var. *utahensis* (S. Watson) C.L. Hitchc. (48) B, D, F, L, M, P, S, W; 2285–3500m; af, bs, dm, ds, fw, sa, sf, wm, wt.

Lupinus polyphyllus Lindl. var. *humicola* (A. Nelson) Barneby (24) D, F, L, M, S, W; 2065–3170m; bs, dm, ds, fw, lf, sf, wf.

Lupinus polyphyllus Lindl. var. *prunophilus* (M.E. Jones) Phillips (6) D, W; 2640–3210m; bs, dm, gr, wm.

Lupinus sericeus Pursh (19) F, G, L, P, S, W; 2065–2900m; af, bs, dm, gr, jw, lf.

* *Medicago lupulina* L. (5) B, L, M; 1725–2440m; bs, dm, sa, wm.

* *Medicago sativa* L. (9) B, F, L, M, P, T; 2175–2630m; bs, dm, ds.

* *Melilotus albus* Medik. (2) F, T; 2255–2500m; ds.

* *Melilotus officinalis* (L.) Pall. (17) B, D, F, L, M, P, S, T; 1725–3520m; bs, dm, ds, jw, lf, sa, wm.

* *Onobrychis viciifolia* Scop. (3) F, L; 2170–2560m; ds.

Oxytropis borealis DC. var. *viscida* (Nutt.) Welsh (22) D, F, G, M, T, W; 2375–3535m; at, bs, dm, lm, lw, sf, wf.

Oxytropis campestris (L.) DC. var. *cusickii* (Greenm.) Barneby (44) B, D, F, G, P, T; 2440–4110m; at, bs, dm, fw, gr, jw, lf.

Oxytropis campestris (L.) DC. var. *spicata* Hook. (21) D, F, L, P, S, T; 2375–2410m; bs; (var. *gracilis*).

Oxytropis deflexa (Pall.) DC. var. *foliolosa* (Hook.) Barneby (8) G; 2990–3535m; at, dm, lm.

Oxytropis deflexa (Pall.) DC. var. *sericea* Torr. & A. Gray (14) F, G, M, W; 2285–2590m; bd, bs, dm, rs, wm, wt.

Oxytropis lagopus Nutt. var. *atropurpurea* (Rydb.) Barneby (8) B, F, M; 2285–2530m; bs, lw.

Oxytropis lagopus Nutt. var. *lagopus* (2) T; 2255–250m; bs, lf.

Oxytropis multiceps Nutt. (1) S; 2330m; bs.

♦ *Oxytropis nana* Nutt. (1) T; 2255–2410m; bs.

Oxytropis parryi A. Gray (3) F, G; 2680–3050m; dm.

Oxytropis podocarpa A. Gray (4) B, D, F, P; 3180–3565m; at, dm, gr.

Oxytropis sericea Nutt. var. *sericea* (30) D, L, P, S, T, W; 1725–2860m; bs, df, dm, ds.

Psoralidium lanceolatum (Pursh) Rydb. (1) L; 1765–1880m; bs.

Thermopsis rhombifolia (Nutt. ex Pursh) Nutt. ex. Richardson var. *annulocarpa* (A. Nelson) Wms. (3) L; 2065–2860m; bs, dm.

Trifolium andinum Nutt. var. *andinum* (4) L; 1725–2640m; bs, dm.

♦ *Trifolium barnebyi* (Isely) Dorn & Lichvar (17) L; 1725–1990m; jw, lm; WY BLM Sensitive.

Trifolium dasyphyllum Torr. & A. Gray (14) D, P, T; 2840–3500m; bs, dm.

Trifolium gymnocarpon Nutt. (14) B, F, L, P, S; 2285–2610m; bs, dm.

* *Trifolium hybridum* L. (24) B, D, F, G, L, M, W; 2255–2925m; af, bs, lf, lm, sa, sf, wm, wt.

Trifolium longipes Nutt. var. *reflexum* A. Nelson (80) B, D, F, G, L, M, P, S, T, W; 2345–3520m; af, bs, dm, fw, lf, ma, sf, wm, wt.

Trifolium nanum Torrey (8) D, P, T; 2665–3765m; dm.

Trifolium parryi A. Gray var. *montanense* (Rydb.) Welsh (3) D; 3025–3520m; dm.

* *Trifolium pratense* L. (5) B, F, M, P; 2175–2680m; bs, dm, fw,lf.

* *Trifolium repens* L. (23) B, F, L, M, P, T, W; 2210–2925m; af, df, dm, ds, lf, rs, sa, sf, wm.

Vicia americana Muhl. ex Willd. var. *minor* Hook. (9) L, M, T, W; 1850–2620m; bd, bs, dm, wm, wt.

Gentianaceae

Frasera speciosa Douglas ex Griseb. (55) B, D, F, G, L, M, P, T, W; 2285–4025m; af, at, bs, df, dm, gr, sf, wm, wt.

Gentiana affinis Griseb. var. *affinis* (24) B, F, G, M, P, S, T, W; 2375–2850m; bs, dm, fw, ma, rs, wm, wt.

Gentiana algida Pall. (20) B, D, F, G, P, W; 2865–3790m; at, dm, gr, lm, sa, wm, wt.

Gentiana aquatica L. (2) F, G; 2440–2470m; wm.

Gentiana calycosa Griseb. (9) F, G; 2775–3535m; at, dm, sf.

Gentiana prostrata Haenke (8) D, F, G, P, T, W; 2865–3790m; at, wm, wt.

Gentianella amarella (L.) Börner var. *acuta* (Michx.) Herder (48) B, D, F, G, M, P, T, W; 2375–3965m; at, bs, dm, fw, gr, lf, sf, wf, wm, wt.

Gentianella tenella (Rottb.) Börner (9) B, D, F, G, P, T; 2860–3720m; at, gr, ma, wm.

Gentianopsis barbellata (Engelm.) Iltis (3) G, T; 3110–3415m; at, gr.

Gentianopsis detonsa (Rottb.) Ma var. *elegans* (A. Nelson) N.H. Holmgren (25) D, F, G, M, W; 2285–2950m; dm, ma, sa, wm, wt.

Swertia perennis L. (39) B, D, F, G, P, W; 2375–4025m; at, dm, fw, lf, lm, ma, wm, wt.

Geraniaceae

* *Erodium cicutarium* (L.) L'Her. ex Aiton (1) L; 1860m; jw.

Geranium richardsonii Fisch. & Trautv (52) B, D, F, G, L, M, P, S, T, W; 1860–3365m; af, dm, fw, gr, lf, lm, ma, rs, sf, wm, wt.

Geranium viscosissimum Fisch. & C.A. Mey. ex C.A. Mey. var. *incisum* (Torr. & A. Gray) N.H. Holmgren (18) D, F, L, M, T, W; 2155–3210m; af, bs, dm, wm; (var. *nervosum*).

Geranium viscosissimum Fisch. & C.A. Mey. ex C.A. Mey. var. *viscosissimum* (58) B, D, F, G, L, M, P, S, T, W; 1850–3170m; af, bs, df, dm, ds, fw, gr, lf, lm, sf, wm, wt.

Grossulariaceae

Ribes cereum Douglas (83) B, D, F, G, L, M, P, S, T; 1725–3525m; af, bd, bs, df, dm, ds, fw, gr, jw, lm, lw, sf, wf.

Ribes hudsonianum Richards. var. *petiolare* (Dougl.) Jancz. (31) B, D, F, G, L, P, S, T, W; 2325–3200m; af, bs, fw, gr, lf, sf, wm, wt.

Ribes inerme Rydb. var. *inerme* (17) B, F, L, M, W; 2285–2865m; bs, dm, wt.

Ribes lacustre (Pers.) Poir. (56) B, D, F, G, L, P, W; 2065–3600m; af, bs, df, dm, ds, fw, gr, lf, sf, wf, wm, wt.

Ribes montigenum McClatchie (49) B, D, F, G, M, P, T, W; 2375–3475m; af, at, bs, dm, fw, gr, lf, lm, sf, wf, wm.

Ribes oxyacanthoides L. var. *setosum* (Lindl.) Dorn (23) B, D, F, G, L, M, P, T, W; 2315–3390m; af, bs, dm, fw, gr, lf, lm, wm, wt.

Ribes viscosissimum Pursh (26) B, D, F, L, P, T, W; 2255–2895m; af, df, lf, sf.

Haloragaceae

Myriophyllum sibiricum Kom. (5) F, M; 2440–2715m; aq.

♦ *Myriophyllum verticillatum* L. (1) D; 2930–2985m; aq.

Hyacinthaceae

* *Muscari botryoides* (L.) Hill (1) S; 2440–2500m; af.

Hydrocharitaceae

Elodea bifoliata St. John (1) F; 2380m; aq; (E. longivaginata).

Elodea nuttallii (Planchon) St. John (1) F; 2440m; aq.

Iridaceae

Iris missouriensis Nutt. (7) L, S, T; 2260–2620m; af, bs, wm.

Sisyrinchium idahoense Bickn. var. *occidentale* (Bickn.) D. Henderson (18) B, F, G, M, S, W; 2285–2745m; ma, rs, sa, wm, wt.

Sisyrinchium montanum Greene var. *montanum* (2) L, T; 2255–2475m; lm, wm.

Juncaceae

Juncus alpinoarticulatus Chaix (1) F; 2345m; sa.

Juncus arcticus Willd. var. *balticus* (Willd.) Trautv. (56) B, D, F, G, L, M, P, S, T, W; 1725–3170m; af, aq, dm, ds, fw, lf, ma, rs, sa, wm, wt; (*J. balticus*, includes var. *vallicola*).

Juncus biglumis L. (6) D, W; 2865–3790m; ma, wm.

Juncus bufonius L. (5) B, M, S; 2375–2745m; fw, lf, wm.

Juncus castaneus Sm. (9) D, P, W; 2865–3790m; ma, sa, wm, wt.

Juncus confusus Coville (29) B, D, F, G, L, M, T, W; 2160–3120m; bs, df, dm, ds, fw, gr, lf, sa, wm.

Juncus drummondii E. Mey. (66) B, D, F, G, L, M, P, T, W; 2525–4110m; at, dm, fw, gr, lm, sf, wf, wm, wt.

Juncus dudleyi Wiegand (4) D, L, P; 2340–2995m; bs, dm, wm; (*J. tenuis* var. *dudleyi*).

Juncus ensifolius Wikstr. var. *ensifolius* (8) F, L, P, S; 1960–2885m; ma, sa, wm.

Juncus ensifolius Wikstr. var. *montanus* (Engelm.) C.L. Hitchc. (29) B, D, F, G, M, P, S, T, W; 2175–2955m; dm, fw, ma, sa, wm, wt; (includes *J. tracyi*).

Juncus hallii Engelm. (16) B, D, F, P, W; 2680–2895m; bs, dm, fw, ma, wm, wt.

Juncus interior Wiegand (1) P; 2520–2615m; wm.

Juncus longistylis Torr. (21) B, D, F, L, M, P, S, T; 2375–3120m; dm, fw, rs, sa, wm.

Juncus mertensianus Bong. (77) B, D, F, L, M, P, S, T, W; 2210–3965m; at, dm, fw, lf, sa, wm, wt.

Juncus nevadensis S. Watson (12) D, F, L, P; 2175–3100m; af, sa, wm, wt.

Juncus nodosus L. (1) L; 2165m; wm.
Juncus parryi Engelm. (48) B, D, F, G, L, P, W; 2460–3780m; at, dm, fw, gr, sf, wf, wm.
Juncus regelii Buch. (1) P; 2485–2520m; af.
♦ *Juncus triglumis* L. var. *albescens* Lange (12) D, F, P, T; 2875–4025m; ma, sa, wm.
♦ *Juncus vaseyi* Engelm. (6) B, F; 2225–2315m; fw, sa.
Luzula parviflora (Ehrh.) Desv. (94) B, D, F, G, L, M, P, S, T, W; 2255–3795m; af, at, dm, fw, gr, lf, ma, sa, sf, wf, wm, wt.
Luzula spicata (L.) DC. (94) B, D, F, G, M, P, T, W; 2470–4110m; at, bs, dm, fw, gr, lf, sf, wf, wm, wt.
Luzula wahlenbergii Rupr. (2) D, F; 3110–3325m; wm, wt; (*L. piperi*).

Juncaginaceae

Triglochin maritima L. var. *elata* (Nutt.) A. Gray (5) F, G; 2315–2500m; ma, sa.
Triglochin palustris L. (7) F, G, P, W; 2440–2950m; aq, ma, wm.

Lamiaceae

Agastache urticifolia (Benth.) Kuntze var. *urticifolia* (1) F; 2500–2745m; af.
Dracocephalum parviflorum Nutt. (11) B, F, G, L, M; 2255–2955m; af, dm, ds, lf, sa, sf.
Mentha arvensis L. (16) B, F, P, S; 2195–2630m; aq, fw, sa, wm, wt.
Monarda fistulosa L. var. *menthifolia* (Grah.) Fernald (1) L; 1860–1910m; bs.
Prunella vulgaris L. var. *lanceolata* (W.P.C. Barton) Fernald (5) F; 2375–2680m; ma, wm.
Stachys palustris L. var. *pilosa* (Nutt.) Fernald (2) F, S; 2185–2375m; af, wm.

Lentibulariaceae

Utricularia macrorhiza Le Conte (4) B, F, P; 2255–2680m; aq, mb; (*U. vulgaris*).
♦ *Utricularia minor* L. (3) P; 2840–2900m; aq; USFS R2 Sensitive.

Liliaceae (Calochortaceae)

Calochortus eurycarpus Wats. (1) B; 2500m; wm.
Calochortus nuttallii Torr. & A. Gray (20) B, F, G, L, P, T; 1725–2895m; bs, jw.
Fritillaria atropurpurea Nutt. (38) B, F, G, L, M, P, S, T; 1765–3015m; af, bs, df, dm, fw, lf, lw.
Fritillaria pudica (Pursh) Spreng. (5) B, F, M, W; 2470–2965m; af, bs, dm.
Lloydia serotina (L.) Reichenb. var. *serotina* (33) B, D, F, G, P, T, W; 2635–3815m; at, dm, gr, lm, wm.
Prosartes trachycarpa S. Watson (5) L; 1860–2510m; af, rs.

Limnanthaceae

Floerkea proserpinacoides Willd. (12) B, F, M, W; 2375–2895m; af, bs, dm, ds, fw, wm.

Linaceae

Linum lewisii Pursh var. *lewisii* (46) F, G, L, M, T, W; 1725–3525m; bd, bs, dm, ds, jw, lm, lw.

Loasaceae

Mentzelia montana (Davidson) Davidson (2) F; 2375–2440m; bs.

Malvaceae

Iliamna rivularis (Douglas ex Hook.) Greene (4) B, F, L, M; 2285–2590m; bs, dm, ds.
* *Malva neglecta* Wallr. (1) B; 2560–2620m; ds.
Sphaeralcea coccinea (Nutt.) Rydb. (7) B, F, L, T; 1725–2390m; bs, dm, ds, jw.

Melanthiaceae (Liliaceae)

Zigadenus elegans Pursh (57) B, D, F, G, L, P, T, W; 2300–3795m; af, at, dm, fw, gr, lf, lm, sf, wm, wt.
Zigadenus paniculatus (Nutt.) Wats. (1) F; 2440–2745m; gr.
Zigadenus venenosus S. Watson var. *gramineus* (Rydb.) Walsh ex Peck (36) B, F, L, P, S; 1725–2530m; af, bs, dm, ds, gr, jw.

Menyanthaceae

Menyanthes trifoliata L. (2) F, P; 2940–3080m; aq.

Myrsinaceae

Glaux maritima L. (1) L; 1725–1915m; dm; (*Lysimachia maritima*).

Najadaceae

♦ *Najas guadalupensis* (Spreng.) Morong (1) F; 2375m; aq; reported by Mohlenbrock (1991)

Nyctaginaceae

Mirabilis linearis (Pursh) Hiemerl (1) B; 2225m; ds.

Nymphaeaceae

Nuphar polysepala Engelm. (19) B, D, F, P, W; 2255–3460m; aq.

Onagraceae

Chamerion angustifolium (L.) Holub var. *angustifolium* (61) B, D, F, G, L, M, P, S, T, W; 2255–3565m; af, at, bd, bs, ds, fw, gr, lf, lm, ma, sa, sf, wm, wt; (*Epilobium angustifolium* var. *angustifolium*.).
Chamerion angustifolium (L.) Holub var. *canescens* (A.W. Wood) N.H. Holmgren & P.K. Holmgren (11) B, D, F, L, M, P; 2315–3120m; dm, fw, lf, sa, wm; (*Epilobium angustifolium* var. *canescens*).
Chamerion latifolium (L.) Holub (3) M; 2315–2995m; dm, sa; (*Epilobium latifolium*).
Epilobium anagallidifolium Lam. (25) B, D, F, G, L, M, P, T, W; 2605–3965m; at, dm, fw, gr, lm, ma, wm, wt.
Epilobium brachycarpum Presl (17) B, F, L, M; 1860–2800m; bs, dm, ds, lf, sa, wm.
Epilobium ciliatum Raf. var. *ciliatum* (34) B, F, G, M, P, S, T, W; 2285–3080m; af, df, dm, fw, ma, sa, wm, wt.
Epilobium ciliatum Raf. var. *glandulosum* (Lehm.) Dorn (3) S, W; 2375–2680m; fw.
Epilobium clavatum Trel. (27) D, F, G, P, T, W; 2730–3670m; at, dm, fw, gr, lm, ma, wm, wt.
Epilobium halleanum Hausskn. (51) B, D, F, G, L, M, P, W; 2375–3720m; at, bs, df, dm, fw, gr, lf, ma, sf, wm, wt.
Epilobium hornemannii Rchb. var. *hornemannii* (24) B, D, F, L, M, P, T, W; 2315–3250m; fw, sa, wm, wt.
Epilobium lactiflorum Hausskn. (23) B, D, F, G, M, P, W; 2530–3720m; at, dm, fw, lf, ma, sa, sf, wm, wt.
Epilobium oregonense Hausskn. (1) W; 2600–2690m; fw.
Epilobium palustre L. var. *gracile* (Farw.) Dorn (1) W; 2600–2690m; fw.
Epilobium palustre L. var. *palustre* (3) F, G; 2375–2440m; ma, wm.
Epilobium pygmaeum (Speg.) Hoch & Raven (1) S; 2350m; rs; (*Boisduvalia glabella*).
Epilobium saximontanum Hausskn. (27) B, D, F, G, L, M, P, T, W; 2335–3455m; dm, fw, lf, lm, ma, sa, wm, wt.
Epilobium suffruticosum Nutt. (5) M; 2315–2440m; sa.
Gayophytum decipiens F.H. Lewis & Szweyk. (2) F, S; 2315m; bs.
Gayophytum diffusum Torr. & A. Gray var. *strictipes* (Hook.) Dorn (53) B, D, F, L, M, P, S, W; 2255–3460m; af, bs, dm, ds, gr, lf, lm, rs, sa, sf, wm.
Gayophytum racemosum Torr. & A. Gray (21) B, F, M, P, S; 2285–3295m; af, bs, dm, ds, fw, gr, lf, lm, wm.
Gayophytum ramosissimum Torr. & A. Gray (18) B, F, M, S; 2225–2680m; bs, dm, ds, sa.
Oenothera cespitosa Nutt. var. *cespitosa* (17) L, M, T, W; 1790–3525m; af, bd, bs, df, dm, jw, lw.
Oenothera flava (A. Nelson) Garrett (2) F; 2375–2410m; bs, ds.
Oenothera nuttallii Sweet (3) F, P, T; 2175–2410m; bs, ds.
Oenothera pallida Lindl. var. *trichocalyx* (Nutt.) Dorn (3) L; 1960–1990m; jw.

Oenothera suffrutescens (Ser.) W.L. Wagner & Hoch (4) L; 1725–1975m; bs, jw; (*Gaura coccinea*).

Oenothera villosa Thunb. var. *strigosa* (Rydb.) Dorn (2) F, L; 2255–2600m; ds.

Taraxia breviflora (Torr. & A. Gray) Nutt. ex Small (8) F, M; 2345–2715m; bs, rs, sa, wm; (*Camissonia breviflora*).

Taraxia subacaulis (Pursh) Rydb. (6) F, S, W; 2375–2790m; bs, dm, wt; (*Camissonia subacaulis*).

Orchidaceae

Calypso bulbosa (L.) Oakes var. *americana* (R. Br.) Luer (3) F, G, W; 2470–2745m; af, lf, sf.

Corallorhiza maculata (Raf.) Raf. var. *maculata* (9) B, L, P; 2255–2505m; af, df, lf.

Corallorhiza maculata (Raf.) Raf. var. *occidentalis* (Lindl.) Ames (1) P; 2680m; fw.

Corallorhiza striata Lindl. (1) L; 2300–2500m; af.

Corallorhiza trifida Châtel (15) B, D, F, G, L, P, W; 2390–3390m; af, fw, wm, wt.

Corallorhiza wisteriana Conrad (1) L: 2465–2510m; lf.

♦ *Cypripedium parviflorum* Salisb. var. *pubescens* (Willd.) Knight (1) L; 1950m; fw; USFS R2 & USFS R4 Sensitive.

Listera borealis Morong (4) G, W; 2750–3110m; ma, sf.

Piperia unalascensis (Spreng.) Rydb. (3) B, F; 2500–2745m; af.

Platanthera aquilonis Sheviak (14) D, F, G, L, M, W; 1860–3120m; fw, ma, sa, wm, wt; (*Habenaria hyperborea*).

Platanthera dilatata (Pursh) Lindl. ex L.C. Beck var. *albiflora* (Cham.) Ledeb. (6) P, W; 2605–2925m; fw, ma, gr.

Platanthera dilatata (Pursh) Lindl. ex L.C. Beck var. *dilatata* (20) B, D, F, G, P, W; 2345–3230m; af, fw, ma, wm.

Platanthera huronensis (Nutt.) Lindl. (14) B, F, G, M; 2285–2865m; fw, ma, sa, sf, wm; (*Habenaria hyperborea*).

Platanthera obtusata (Banks ex Pursh) Lindl. (6) F, G, W; 2515–2590m; ma, sf.

Spiranthes romanzoffiana Cham. (23) B, D, F, G, M, P, S, T; 2255–3160m; lf, ma, sa, wm, wt.

Orobanchaceae (Scrophulariaceae)

castilleja angustifolia (Nutt.) G. Don var. *angustifolia* (5) L; 1725–2560m; bs, dm.

Castilleja angustifolia (Nutt.) G. Don var. *dubia* A. Nelson (16) B, L, P, S, T; 2065–2700m; bs, dm, gr, jw.

Castilleja cusickii Greenm. (32) B, D, F, M, P, T, W; 2680–3270m; bs, dm, wm, wt.

Castilleja flava S. Watson var. *flava* (46) B, F, G, L, M, S, T, W; 2165–2895m; bd, bs, df, dm, lm, wm, wt.

Castilleja linariifolia Benth. (35) B, D, F, G, L, M, P, S, T, W; 2255–3160m; af, bs, df, dm, fw, lf; (includes hybrids with *C. miniata*).

Castilleja miniata Douglas ex Hook. var. *miniata* (84) B, D, F, G, L, M, P, S, W; 2210–3350m; af, dm, fw, gr, lf, ma, sa, sf, wm, wt.

Castilleja pallescens (A. Gray) Greenm. (33) L, P, S, T; 1765–3525m; bs, df, dm, gr, jw.

Castilleja pilosa (Wats.) Rydb. var. *longispica* (A. Nels.) N. Holmgren (17) F, M, S, T, W; 2315–2905m; bd, bs, dm.

Castilleja pulchella Rydb. (58) B, D, F, G, P, T, W; 2635–3840m; at, dm, gr, lm.

Castilleja rhexifolia Rydb. (48) B, D, F, G, M, P; 2375–3840m; af, at, dm, fw, gr, ma, sf, wf, wm, wt.

Castilleja sulphurea Rydb. (34) B, F, G, M, T; 2315–3475m; af, at, bd, bs, dm, fw, gr, lf, lm, sf, wm.

Cordylanthus ramosus Nutt. ex Benth. (5) B, F, M, S; 2225–2410m; bs.

Orobanche fasciculata Nutt. (12) B, F, L, M, P, S; 1765–2865m; bs, dm, fw, jw.

Orobanche ludoviciana L. var. *ludoviciana* (1) G; 2440m; bs.

Orobanche uniflora L. (14) B, F, L, M, P; 2160–3365m; af, bs, dm, ds, gr, wf, wm.

Orthocarpus luteus Nutt. (27) B, D, F, G, L, M, S: 2195–2940m; bs, dm, ds, wm.

Pedicularis bracteosa Benth. var. *paysoniana* (Pennell) Cronquist (67) B, D, F, G, L, M, P, T, W; 2325–3815m; af, at, dm, fw, gr, lf, sa, sf, wm, wt.

Pedicularis contorta Benth. var. *contorta* (1) F; 3050–3350m; wm.

Pedicularis groenlandica Retz (107) B, D, F, G, L, M, P, S, T, W; 2285–3840m; at, bs, dm, fw, gr, lf, ma, sa, wm, wt.

Pedicularis parryi A. Gray var. *parryi* (43) B, D, F, G, L, P, T, W; 2375–3815m; at, bs, df, dm, fw, gr, lf, ma, sf, wf, wm, wt.

Pedicularis parryi A. Gray var. *purpurea* Parry (20) D, F, G, M, T, W; 2530–3415m; at, bs, dm, lm, sf, wf, wm, wt.

Pedicularis procera A. Gray (6) B, F, G, M, W; 2255–2800m; af, fw, lf, sf.

♦ *Pedicularis pulchella* Pennell (1) T; 2665–3525m; dm.

Pedicularis racemosa Douglas ex Benth. var. *alba* (Pennell) Cronquist (16) B, D, F, G, M, W; 2680–3270m; dm, fw, sf, wf.

Papaveraceae (Fumariaceae)

Corydalis aurea Willd. var. *aurea* (22) B, F, G, L, M, S, T, W; 2255–2800m; af, bs, df, dm, fw, gr, lf, wt.

♦ *Papaver radicatum* Rottb. ssp. *kluanense* (D. Löve) D.F. Murray (6) D, F, P; 3155–4110m; at, gr; (*P. coloradense*, *P. kluanense*, *P. lapponicum*).

Parnassiaceae (Saxifragaceae)

parnassia fimbriata König var. *fimbriata* (47) B, D, F, M, P, S, W; 2255–3600m; at, dm, fw, sa, sf, wm, wt.

♦ *Parnassia kotzebuei* Cham. ex Spreng. (5) D, G; 2935–3420m; at, fw, lm, wm, wt; USFS R2 Sensitive.

Parnassia palustris L. var. *montanensis* (Fern. & Rydb. ex Rydb.) C.L. Hitchc. (10) F, G, M, P; 2345–2490m; ma, wm, wt.

Phrymaceae (Scrophulariaceae)

Mimulus breweri (Greene) Coville (6) B, F; 2440–2895m; bd, gr, lf, sa, wm.

Mimulus floribundus Lindl. (6) B, F, L, T; 2315–2620m; gr, lf, wm.

Mimulus guttatus DC. (42) B, F, G, L, M, P, S, T, W; 1860–3050m; fw, lm, ma, sa, wm, wt.

Mimulus lewisii Pursh (21) B, D, F, M, P, W; 2440–3365m; fw, sa, wm, wt.

Mimulus suksdorfii A. Gray (17) B, F, S; 2225–2745m; bs, dm, gr, sa.

Mimulus washingtonensis Gand. (5) B, D, F, G, P; 2440–2900m; bd, gr, lm, wm; (*M. patulus*).

Plantaginaceae (Callitrichaceae, Hippuridaceae, Scrophulariaceae)

Besseya wyomingensis (A. Nelson) Rydb. (49) B, D, F, G, L, M, P, T, W; 1850–3840m; at, bs, dm, gr, lm, lw, wm.

Callitriche hermaphroditica L. (4) F, M, W; 2440–3460m; aq.

Callitriche heterophylla Pursh (1) B; 2745m; aq.

Callitriche palustris L. (29) B, D, F, G, L, M, P, S, W; 1960–3160m; aq, ma, sa, wm; wt.

Collinsia parviflora Lindl. (89) B, D, F, G, L, M, P, S, T, W; 1850–3295m; af, bs, df, dm, ds, gr, lf, sf, wf, wm, wt.

Hippuris vulgaris L. (6) D, F, G, M, P; 2470–2970m; aq, ma, sa.

Limosella aquatica L. (4) B, F, M, S; 2225–2440m; aq, ma.

*● *Linaria dalmatica* (L.) Mill. var. *dalmatica* (1) L; 1765–1880m; bs.

*● *Linaria vulgaris* Mill. (2) F, L; 2440m; ds.

Penstemon arenicola A. Nelson (1) F; 2375m; bs.

Penstemon attenuatus Dougl. ex Lindl. var. *pseudoprocerus* (Rydb.) Cronq. (21) D, F, G, M, W; 2375–3535m; at, dm, gr, lm, sf.

Penstemon deustus Dougl. ex Lindl. var. *deustus* (3) B, F; 2315–2620m; gr, lf, sf.

Penstemon eriantherus Pursh var. *cleburnei* (Jones) Dorn (10) L, T; 1725–2905m; bs, dm, jw.

Penstemon eriantherus Pursh var. *eriantherus* (6) L, T, W; 1860–3110m; bs, sa, sf.

Penstemon glaber Pursh var. *glaber* (4) L; 1790–1975m; jw.
Penstemon humilis Nutt. ex A. Gray var. *humilis* (41) B, F, L, P, S, T; 1765–3180m; bs, df, dm, ds, gr, jw, lf.
Penstemon laricifolius Hook. & Arn. var. *laricifolius* (7) L, T; 1725–2635m; bs, jw, lm.
Penstemon montanus Greene var. *montanus* (8) F, G, M; 2865–3535m; at, dm, gr, lm.
♦ *Penstemon paysoniorum* Keck (3) L; 1960–1975m; jw.
Penstemon procerus Douglas ex Graham var. *procerus* (108) B, D, F, G, L, M, P, S, T, W; 2260–3795m; af, at, bs, dm, ds, fw, gr, lf, lm, ma, rs, wf, wm.
Penstemon radicosus A. Nelson (29) B, F, G, L, P, S, T; 1850–2905m; bs, dm.
Penstemon strictus Benth. (20) B, F, L, P; 2160–2900m; bs, dm, ds, lf, sa, sf, wm.
Penstemon subglaber Rydb. (16) F, G, M, T, W; 2285–3050m; af, df, dm, ds, lf, lw, sf, wm, wt.
Penstemon whippleanus A. Gray (23) D, F, G, M, P, T, W; 2500–3520m; af, at, bs, dm, fw, gr, lm, wm.
Plantago eriopoda Torr. (2) F, W; 2440–2690m; ds.
* *Plantago major* L. (3) M, W; 2345–2470m; dm, ds, fw.
Plantago patagonica Jacq. (2) L; 1725–1990m; bs.
Plantago tweedyi A. Gray (11) D, F, M, S, W; 2375–2955m; bs, dm, ds, fw, wm, wt.
Veronica americana Schwein. ex Benth. (36) B, D, F, G, L, M, P, S, W; 2065–3085m; af, aq, fw, ma, sa, wm, wt.
* *Veronica anagallis-aquatica* L. (1) L; 2065–2175m; fw.
* *Veronica biloba* L. (14) B, F, L, M, S; 2210–2745m; af, bs, ds, wm.
Veronica peregrina L. var. *xalapensis* (Kunth) H. St. John & F.W. Warren (15) B, F, L, M, T; 1860–2895m; bs, dm, ds, gr, lf, sa, sf, wm, wt.
Veronica scutellata L. (3) F, G; 2440–2715m; af, ma, wt.
Veronica serpyllifolia L. var. *humifusa* (Dicks.) Vahl (65) B, D, F, L, M, P, S, W; 2255–3830m; af, dm, fw, lf, ma, sa, sf, wm, wt.
Veronica wormskjoldii Roem. & Schult. (94) B, D, F, G, L, M, P, T, W; 2375–3965m; at, dm, fw, gr, lf, ma, wm, wt.

Poaceae

Achnatherum contractum (B.L. Johnson) Barkworth (2) M, S; 2315–2520m; bs, sa; (*Oryzopsis contracta*).
Achnatherum hymenoides (Roem. & Schult.) Barkworth (24) B, F, G, L, M, S, T; 1725–2745m; bd, bs, gr, jw, lm, lw; (*Oryzopsis hymenoides*).
Achnatherum lettermanii (Vasey) Barkworth (24) B, D, F, L, M, P, T, W; 2210–3420m; at, bs, dm, fw, gr; (*Stipa lettermanii*).
Achnatherum nelsonii (Scribn.) Barkworth ssp. *dorei* (Barkworth & J. Maze) Barkworth (46) B, D, F, G, L, M, T, W; 2255–3240m; af, bs, df, dm, ds, fw, gr, lm, sa, sf, wf, wm, wt; (*Stipa nelsonii* var. *dorei*).
Achnatherum nelsonii (Scribn.) Barkworth ssp. *nelsonii* (16) B, D, F, L, P, W; 1765–3230m; bs, dm, lf, sf; (*Stipa nelsonii* var. *nelsonii*).
Achnatherum occidentale (Thurb.) Barkworth (2) B, W; 2380–2680m; bs; (*Stipa occidentalis*).
Achnatherum pinetorum (Jones) Barkw. (2) B, P; 2440m; dm; (*Stipa pinetorum*).
Achnatherum richardsonii (Link) Barkworth (11) F, G, M, T; 2315–2680m; bs, fw, lm, wt; (*Stipa richardsonii*).
* *Agropyron cristatum* (L.) Gaertn. var. *cristatum* (4) B, F, S; 2255–2375m; bs, ds.
* *Agropyron cristatum* (L.) Gaertn. var. *desertorum* (Fisch. ex Link) Dorn (3) F, L, S; 2265–2375m; bs.
* *Agropyron cristatum* (L.) Gaertn. var. *fragile* (Roth) Dorn (1) S; 2315–2345m; bs.
Agrostis exarata Trin. (20) B, F, M, P, W; 2315–2950m; bs, fw, ma, sa, wt.
Agrostis idahoensis Nash (6) B, D, P, W; 2680–2885m; fw, wm.
♦ *Agrostis mertensii* Trin. (1) D; 2975–3270m; wt.
Agrostis scabra Willd. (83) B, D, F, G, L, M, P, S, T, W; 2175–3720m; af, at, bs, df, dm, ds, fw, gr, lf, sa, sf, wf, wm, wt.
* *Agrostis stolonifera* L. (14) B, F, L, M, S, W; 2195–2745m; bs, dm, fw, ma, sa, wm, wt.
Agrostis variabilis Rydb. (26) B, D, F, G, P, W; 2785–3790m; at, dm, gr, lm, ma, sf, wf, wm, wt.
Alopecurus aequalis Sobol. var. *aequalis* (39) B, D, F, G, L, M, P, S, T, W; 2225–3460m; af, aq, df, dm, fw, ma, sa, wm, wt.
* *Alopecurus arundinaceus* Poir. (3) L; 1725–2670m; wm.
Alopecurus magellanicus Lam. (6) D, F, P, W; 2645–3210m; dm, fw, wm; (*A. alpinus*, *A. borealis*).
* *Alopecurus pratensis* L. (20) B, F, M, P, S, W; 2255–2970m; af, bs, dm, ds, lf, ma, sa, wm, wt.
Anthoxanthum hirtum (Schrank) Schouten & Veldkamp (25) B, D, F, G, L, M, P, S, T; 2315–3185m; fw, rs, wm, wt; (*Hierochloe odorata*).
* *Arrhenatherum elatius* (L.) J. & K. Presl (1) L; 1890m; wt.
Beckmannia syzigachne (Steud.) Fernald (7) B, F, G, T, W; 2255–2795m; dm, wt.
Bromus carinatus Hook. & Arn. (37) B, D, F, L, M, P, T, W; 1860–3115m; af, bs, dm, ds, gr, lf, sa, wm, wt.
Bromus ciliatus L. (44) B, D, F, G, L, M, P, S, W; 1860–3365m; af, dm, fw, lf, ma, sf, wm, wt.
* *Bromus commutatus* Schrad. (4) F, L; 1960–2285m; ds, jw.
* *Bromus inermis* Leyss. (44) B, D, F, L, M, T, W; 1790–3210m; bs, dm, ds, jw, wm; (var. *inermis*).
* *Bromus japonicus* Thunb. ex Murray (1) F; 2255–2315m; bs.
Bromus porteri (J.M. Coult.) Nash (33) B, D, F, G, L, M, P, T, W; 2175–3160m; af, bs, df, dm, ds, fw, lw, sa, wm, wt; (*B. anomalus*).
Bromus pumpellianus Scribn. (6) F, G, T, W; 2635–3415m; at, dm, wt; (*B. inermis* var. *purpurascens*).
* *Bromus secalinus* L. (1) L; 1960–1990m; jw.
* *Bromus tectorum* L. (34) B, F, L, P, S, T; 1725–2865m; af, bs, dm, ds, gr, jw, lm, wt.
Calamagrostis canadensis (Michx.) P. Beauv. var. *canadensis* (68) B, D, F, G, L, M, P, T, W; 1960–3720m; af, bs, fw, gr, lf, ma, rs, sa, sf, wm, wt.
Calamagrostis inexpansa A. Gray (7) D, G, M, P, S; 2285–3420m; bs, dm, ma, wm.
Calamagrostis montanensis Scribn. ex Vasey (2) B, D; 3230–3325m; wf.
Calamagrostis purpurascens R. Br. var. *purpurascens* (28) B, D, F, G, P, T; 2850–4410m; at, dm, fw, gr, lm.
Calamagrostis rubescens Buckley (1) W; 2530–2565m; sf.
Calamagrostis scopulorum Jones (1) W; 2745m; ma.
Calamagrostis stricta (Timm) Koeler (16) B, D, F, M, P, S, W; 2345–4025m; dm, fw, ma, sa, wm.
Catabrosa aquatica (L.) Beauv. (5) F, L; 2260–2620m; af, wm, wt.
* *Dactylis glomerata* L. (16) B, F, L, M, P, S, W; 1790–3050m; bs, dm, ds, jw, sf, wm.
Danthonia intermedia Vasey (58) B, D, F, G, M, P, S, T, W; 2315–3840m; af, at, bs, dm, gr, lf, lm, ma, sf, wf, wm, wt.
Danthonia unispicata (Thurb.) Munro ex Macoun (17) B, F, L, M, P, T; 1725–2990m; af, bs, dm, ds, jw, lf.
Deschampsia cespitosa (L.) P. Beauv. var. *cespitosa* (153) B, D, F, G, L, M, P, S, T, W; 2225–3815m; at, bs, dm, fw, gr, lf, ma, sa, wm, wt.
Deschampsia elongata (Hook.) Munro (1) W; 2680m; sf.
Distichlis spicata (L.) Greene (1) L; 1720–1915m; rs; (*D. stricta*).
Elymus albicans (Scribn. & J.G. Sm.) Á. Löve (11) F, G, L, T; 1960–2745m; bs, df, dm, jw; (var. *griffithsii*).
Elymus canadensis L. var. *canadensis* (2) L, M; 1890–2440m; dm, wm.
Elymus cinereus Scribn. & Merr. (14) F, L, M, P, S, T; 1860–3155m; bs, ds, lf, sa.
* *Elymus elongatus* (Host) Runemark var. *ponticus* (Podp.) Dorn (1) F; 2285m; ds.

Elymus elymoides (Raf.) Swezey var. *brevifolius* (J. G. Sm.) Dorn (23) B, D, F, G, L, P, T, W; 2175–3240m; bs, dm, fw, gr, sa, wm, wt.
Elymus elymoides (Raf.) Swezey var. *elymoides* (51) B, D, F, G, L, M, P, S, T, W; 2285–3415m; af, at, bd, bs, dm, ds, gr, lf, lm, sa, sf, wf, wt.
Elymus glaucus Buckley var. *glaucus* (19) B, D, F, G, L, P, W; 1860–3330m; bs, dm, fw, gr, lf, rs, sa, sf.
* *Elymus hispidus* (Opiz) Melderis var. *hispidus* (2) F, P; 2440–2575m; ds, lf.
* *Elymus hispidus* (Opiz) Melderis var. *ruthenicus* (Griseb.) Dorn (1) F; 2375m; ds.
* *Elymus junceus* Fisch. (1) S; 2315–2345m; ds.
Elymus lanceolatus (Scribn. & J.G. Sm.) Gould var. *lanceolatus* (10) B, L, M, S, T, W; 1765–3655m; at, bd, bs, dm, gr, jw, sf.
Elymus lanceolatus (Scribn. & J.G. Sm.) Gould var. *riparius* (Scribn. & J.G. Sm.) Dorn (5) P, W; 2605–3795m; at, bs, dm, fw.
*● *Elymus repens* (L.) Gould (5) B, F, P; 2375–2800m; sa, wm.
Elymus scribneri (Vasey) M.E. Jones (54) B, D, F, G, L, M, P, T, W; 2730–4110m; at, dm, gr, lm, sf, wf, wm.
Elymus smithii (Rydb.) Gould (3) D, F; 2440–2995m; dm, ds.
Elymus spicatus (Pursh) Gould (51) B, F, G, L, M, P, S, T; 1725–3455m; bd, bs, df, dm, ds, gr, jw, lm, lw, sa, wm; (includes hybrids with *E. elymoides* [*E. saxicolus*]).
Elymus trachycaulus (Link) Gould ex Shinners var. *trachycaulus* (130) B, D, F, G, L, M, P, S, T, W; 1860–3790m; af, at, bs, df, dm, ds, fw, gr, lf, lm, ma, rs, sa, sf, wf, wm, wt; (includes hybrids with *E. elymoides* [*E. saundersii*], var. *andinus*).
Festuca baffinensis Polunin (7) D, G, P, T; 3150–3700m; at, dm.
Festuca brachyphylla Schult. ex Schult. & Schult. f. var. *coloradensis* (Fred.) Dorn (73) B, D, F, G, M, P, T, W; 2800–4110m; at, dm, gr, lm, sf, wm.
Festuca idahoensis Elmer (89) B, D, F, G, L, M, P, S, T, W; 1725–3625m; af, bs, df, dm, ds, gr, jw, lf, lw, sa, sf, wt.
Festuca minutiflora Rydb. (6) D, P, T; 2635–3830m, at, dm, gr.
Festuca rubra L. ssp. *rubra* (6) G, P, T, W; 2555–3210m; bs, dm.
Festuca saximontana Rydb. var. *saximontana* (40) B, D, F, L, M, P, S, T, W; 2160–3655m; at, bs, dm, ds, fw, gr, lf, sa, sf, wf, wm, wt.
♦ *Festuca viviparoidea* Krajina ex Pavlick ssp. *krajinae* Pavlick (4) D, G; 3415–3530m; at.
Glyceria borealis (Nash) Batch (10) B, F, P; 2255–2865m; af, aq, dm, wm.
Glyceria elata (Nash ex Rydb.) M.E. Jones (2) P, T; 2255–2615m; aq, fw.
Glyceria grandis S. Watson var. *grandis* (9) B, D, F, L, P, W; 2375–2985m; aq, fw, wt.
Glyceria striata (Lam.) Hitchc. var. *stricta* (Scribn.) Henr. (20) B, D, F, G, L, P, W; 1860–2860m; aq, fw, ma, wm, wt.
♦ *Helictotrichon mortonianum* (Scribn.) Henr. (2) T; 3230–3535m; dm.
Hesperostipa comata (Trin. & Rupr.) Barkworth var. *comata* (13) L, P, T, W; 1765–2520m; bs, ds, jw; (*Stipa comata* var. *comata*).
Hesperostipa comata (Trin. & Rupr.) Barkworth var. *intermedia* (Scribn. & Tweedy) Dorn (12) B, F, M, S; 2315–2800m; af, bs, dm; (*Stipa comata* var. *intermedia*; includes hybrids named *S. × bloomeri*).
Hordeum brachyantherum Nevski (31) B, D, F, L, M, P, S, T, W; 2315–3155m; bs, dm, ds, fw, sa, wm, wt; (includes hybrid *H. × caespitosum* with *H. jubatum*).
Hordeum jubatum L. (15) B, F, T; 2225–2925m; bs, dm, sa; (includes hybrids with *E. trachycaulus* [*Elymus macounii*]).
Koeleria macrantha (Ledeb.) Schult. (48) B, F, G, L, M, S, T, W; 1725–2905m; bs, df, dm, ds, jw, lf, lm, lw, ma, sa, sf, wm.
Leucopoa kingii (S. Watson) W.A. Weber (90) B, D, F, G, L, M, P, S, T, W; 1790–3700m; at, bd, bs, df, dm, ds, fw, gr, jw, lf, lm, lw, sf, wm.
Melica bulbosa Geyer ex Porter & J.M. Coult. (30) B, F, L, P, S, T; 1850–3295m; af, bs, dm, ds, gr.
Melica spectabilis Scribn. (15) F, L, M, T, W; 2330–3180m; af, bs, dm, ds, gr, lf, sf, wm.
Muhlenbergia andina (Nutt.) Hitchc. (6) F, M, S; 2285–2800m; af, bs, gr, lf.
Muhlenbergia filiformis (Thurb. ex Wats.) Rydb. var. *filiformis* (16) B, F, G, M, P, S; 2285–3090m; bs, dm, wm, wt.
♦ *Muhlenbergia glomerata* (Willd.) Trin. (1) D; 2985–3000m; fw.
Muhlenbergia richardsonis (Trin.) Rydb. (14) B, D, F, G, M, P, S, T; 2255–3000m; bs, ds, lm, wf, wm.
Nassella viridula (Trin.) Barkw. (1) T; 2285–2560m; dm; (*Stipa viridula*).
Phalaris arundinacea L. (3) B, F, L; 1860–2895m; lf, rs, wm.
♦ *Phippsia algida* (Phipps) R. Br. (3) D, F; 3310–3965m; at, gr, wm.
Phleum alpinum L. var. *alpinum* (115) B, D, F, G, L, M, P, S, T, W; 2375–3830m; af, at, bs, dm, ds, fw, gr, lf, ma, sa, wm, wt.
* *Phleum pratense* L. var. *pratense* (32) B, F, G, L, M, P, S, T, W; 1860–3210m; bs, df, dm, ds, rs, sa, wm, wt.
Piptatherum exiguum (Thurb.) Dorn (33) B, F, G, L, P, S, W; 2315–3110m; af, bs, df, dm, ds, fw, gr, lf, sf; (*Orzyopsis exigua*).
Poa abbreviata R. Br. ssp. *pattersonii* (Vasey) Á. Löve, D. Löve, & B.M. Kapoor (28) B, D, F, G, P, T, W; 2635–3830m; dm, fw, gr, lm, sa, wm; (*P. pattersonii*).
Poa alpina L. var. *alpina* (87) B, D, F, G, M, P, T, W; 2315–3900m; at, bs, dm, fw, gr, lm, ma, sa, wm, wt.
* *Poa annua* L. (16) B, F, M, S; 2255–3050m; af, df, dm, ds, fw, sa, wm, wt.
Poa arctica R. Br. ssp. *grayana* (Vasey) Á. Löve, D. Löve, & B.M. Kapoor (24) B, D, F, G, L, P; 2370–3830m; af, at, dm, gr, ma, sa, wf, wm.
Poa arida Vasey (9) F, L, P, S, T, W; 1725–2945m; bs, dm, ds.
* *Poa bulbosa* L. (2) B; 2225–2500m; af, ds.
Poa cusickii Vasey var. *cusickii* (60) B, D, F, G, L, M, P, S, T, W; 1725–3755m; at, bd, bs, dm, ds, fw, gr, jw, lf, lm, wm; (ssp. *pallida*).
Poa cusickii Vasey var. *epilis* (Scribn.) C.L. Hitchc. (82) B, D, F, M, P, S, T, W; 2555–4110m; at, bs, dm, gr, sf, wf, wm, wt.
Poa fendleriana (Steud.) Vasey (81) B, D, F, G, L, M, P, S, T, W; 2175–3625m; af, bs, df, dm, fw, gr, lw, wm, wt.
Poa glauca Vahl. var. *rupicola* (Nash ex Rydb.) B. Boivin (50) B, D, F, G, P, T, W; 2290–3765m; at, dm, gr, lm, wm, wt.
Poa interior Rydb. (89) B, D, F, G, L, M, P, S, T, W; 2075–3535m; af, at, bd, bs, df, dm, fw, gr, lf, lm, sa, sf, wf, wm, wt.
Poa leptocoma Trin. (41) B, D, F, G, L, M, P, T, W; 2340–3695m; af, at, dm, fw, gr, lm, ma, sf, wm, wt.
Poa lettermanii Vasey (7) B, D, P; 2605–4025m; at, dm, lm, wm.
Poa palustris L. (57) B, D, F, G, L, M, P, S, T; 1860–3120m; af, ds, fw, lf, sa, wm, wt.
* *Poa pratensis* L. (74) B, D, F, G, L, M, P, S, T, W; 1860–3790m; af, bs, dm, ds, fw, gr, lf, lm, ma, sa, sf, wm, wt.
Poa reflexa Vasey & Scribn. (53) B, D, F, G, M, P, T, W; 2470–3670m; af, at, dm, fw, gr, sf, wf, wm, wt.
Poa secunda J. Presl ssp. *juncifolia* (Scribn.) Soreng (21) B, D, F, G, L, M, P, S, T, W; 1725–3560m; af, at, bs, dm, ds, jw, lf, lm, sf, wm, wt; (includes *P. nevadensis* & *P. juncifolia*).
Poa secunda J. Presl ssp. *secunda* (210) B, D, F, G, L, M, P, S, T, W; 1725–4110m; af, at, bs, df, dm, ds, fw, gr, jw, lf, lm, rs, sa, sf, wf, wm, wt; (includes *P. gracillima* & vars. *incurva* and *elongata*).
* *Poa trivialis* L. (4) D, F, T; 2285–3110m; bs, dm.
Poa wheeleri Vasey (164) B, D, F, G, L, M, P, S, T, W; 1850–3655m; af, at, bs, df, dm, ds, fw, gr, lf, lm, sf, wf, wm; (*P. nervosa*).
Podagrostis humilis (Vasey) Björkman (38) B, D, F, P, T; 2575–3720m; at, fw, gr, ma, sa, wf, wm, wt; (*Agrostis humilis, A. thurberiana*).
* *Puccinellia distans* (L.) Parl. (1) F, 2305m, wm.
* *Schedonorus pratensis* (Huds.) P. Beauv. (3) G, L, W; 2440–2565m; dm, sa; (*Festuca pratensis*).
# *Schizachne purpurascens* (Torr.) Swall. (1) G; 2440m; dm.
Torreyochloa pallida (Torr.) G.L. Church var. *pauciflora* (J. Presl) J.I. Davis (9) B, F, P, S; 2375–3080m; fw, lf, wm, wt.
Trisetum spicatum (L.) K. Richt. (177) B, D, F, G, L, M, P, T, W; 2210–4110m; af, at, bs, dm, fw, gr, lf, lm, ma, sa, sf, wf, wm.

Trisetum wolfii Vasey (17) B, D, F, L, M, P, W; 2255–3240m; bs, dm, fw, gr, sa, sf, wm, wt.
* *Triticum aestivum* L. (2) F; 2255–2375m; ds, sa.
Vahlodea atropurpurea (Wahl.) Fr. ex RH (11) D, F; 2680–3420m; dm, fw, gr, wm, wt; (*Deschampsia atropurpurea*).
Vulpia octoflora (Walt.) Rydb. (2) B, L; 1860–2410m; bs, jw.

Polemoniaceae

Collomia linearis Nutt. (84) B, D, F, G, L, M, P, S, T, W; 2065–3295m; af, bs, df, dm, ds, fw, gr, lf, sf, wm.
Collomia tenella A. Gray (1) L; 2255–2285m; bs.
Gymnosteris parvula Heller (26) B, F, M, P, S; 2255–2940m; bs, dm, gr.
Ipomopsis aggregata (Pursh) V.E. Grant ssp. *aggregata* (21) B, L, P, W; 1860–2900m; af, bs, dm, ds, jw, lf, lm, lw.
Ipomopsis aggregata (Pursh) V.E. Grant ssp. *attenuata* (A. Gray) V.E. Grant & A.D. Grant (31) B, F, G, M, S; 2285–3110m; af, bs, dm, ds, fw, lm, ma, wt.
♦ *Ipomopsis crebrifolia* (Nutt.) Dorn (2) M, S; 2375–2590m; bs.
Ipomopsis spicata (Nutt.) V.E. Grant var. *orchidacea* (Brand) Dorn (2) T; 2285–3230m; dm, ds.
Ipomopsis spicata (Nutt.) V.E. Grant var. *spicata* (21) L, S, T; 1725–3525; bs, df, dm, gr, lw.
Lathrocasis tenerrima (A. Gray) Johnson (17) B, F, P, S; 2255–2750m; af, bs, dm, fw, gr; (*Gilia tenerrima*).
Leptosiphon nuttallii (A. Gray) Porter & Johnson (4) B; 2560–2745m; af, bs; (*Linanthus nuttallii*).
Leptosiphon septentrionalis (H. Mason) J.M. Porter & L.A. Johnson (39) B, D, F, G, M, S, W; 2255–2895m; af, bs, dm, ds, fw, gr, sa; (*Linanthus septentrionalis*).
Linanthus pungens (Torr.) J.M. Porter & L.A. Johnson (20) B, F, L, M, S, T; 1725–2760m; bs, dm, fw, jw; (*Leptodactylon pungens*).
Microsteris gracilis (Hook.) Greene var. *gracilis* (1) L; 1860m; jw.
Microsteris gracilis (Hook.) Greene var. *humilior* (Hook.) Cronquist (9) B, F, L; 2260–2835m; af, bs, ds, gr.
Navarretia breweri (A. Gray) Greene (1) S; 2225–2255m; bs.
Navarretia saximontana Spencer (2) B, F; 2285-2310m; bs, sa; (*N. intertexta* var. *propinqua*).
Phlox andicola E. Nels. (11) L, S; 1860–2640m; bs, dm, lw.
Phlox hoodii Richardson (54) B, F, G, L, M, P, S, T; 1725–3170m; bs, dm, ds, gr, lm, lw.
Phlox longifolia Nutt. var. *longifolia* (30) B, F, L, S; 2065–2590m; af, bs, dm.
Phlox multiflora A. Nelson (128) B, D, F, G, L, M, P, S, T, W; 1850–3420m; af, at, bd, bs, df, dm, ds, fw, gr, jw, lf, sf, wf, wm.
Phlox muscoides Nutt. (1) T; 2255–2410m; bs.
Phlox pulvinata (Wherry) Cronquist (30) B, D, F, P, T; 2665–3790m; at, dm, gr.
♦ *Phlox pungens* Dorn (6) L; 1765–2605m; bs, lm; WY BLM Sensitive.
Polemonium occidentale Greene var. *occidentale* (14) B, F, G, W; 2375–2865m; fw, ma, wm, wt.
Polemonium viscosum Nutt. (70) B, D, F, G, P, T, W; 2665–3965m; at, bs, dm, gr, lm, wm.

Polygonaceae

Bistorta bistortoides (Pursh) Small (148) B, D, F, G, L, M, P, S, T, W; 2160–4055m; af, at, bs, dm, ds, fw, gr, lf, rs, sa, sf, wm, wt; (*Polygonum bistortoides*).
Bistorta vivipara (L.) Delarbre (65) B, D, F, G, M, P, T, W; 2290–4025m; at, dm, fw, gr, ma, sa, wm, wt; (*Polygonum viviparum*).
Eriogonum acaule Nutt. (1) S; 2370m; bs (BM).
Eriogonum brevicaule Nutt. var. *brevicaule* (2) T; 2285–2500m; dm.
Eriogonum brevicaule Nutt. var. *laxifolium* (T. & G.) Reveal (14) F, G, M; 2285–3415m; bd, bs, dm, lm, lw; (var. *bannockense*).
Eriogonum brevicaule Nutt. var. *micranthum* (Nutt.) Reveal (1) T; 2255m; bs.
Eriogonum caespitosum Nutt. (21) B, F, P, S; 2285–2610m; bs, dm, gr.
Eriogonum cernuum Nutt. (4) B, M, S; 2225–2410m; bd, bs, ds.
Eriogonum flavum Nutt. var. *flavum* (15) L, T; 1725–3155m; bs, dm, jw.
Eriogonum microthecum Nutt. var. *laxiflorum* Hook. (1) F; 2225m; bs.
Eriogonum ovalifolium Nutt. var. *ochroleucum* (Small ex Rydb.) Peck (10) L, T; 1725–3155m; bs, dm, ds, jw.
Eriogonum ovalifolium Nutt. var. *ovalifolium* (12) D, F, L, P, S, T; 2315–3170m; bs, dm, gr.
Eriogonum ovalifolium Nutt. var. *purpureum* (Nutt.) T. Durand (44) B, D, F, G, L, M, P, S, T, W; 2285–3720m; at, bs, dm, gr, lm.
Eriogonum umbellatum Torr. var. *majus* Hook. (151) B, D, F, G, L, M, P, S, T, W; 1790–3720m; af, at, bs, dm, ds, gr, jw, lf, lm, lw, sf, wf, wm.
Eriogonum umbellatum Torr. var. *umbellatum* (2) D; 2285–2880m; bs, sa.
♦ *Koenigia islandica* L. (2) D; 3310–3810m; at, wm.
Oxyria digyna (L.) Hill (80) B, D, F, G, M, P, T, W; 2440–4055m; at, dm, fw, gr, lm, sa, sf.
Persicaria amphibia (L.) Gray (5) B, F, G, P; 2255–2680m; aq; (*Polygonum amphibium*).
* *Persicaria maculosa* A. Gray (1) P; 2795–2850m; wm; (*Polygonum persicaria*).
Polygonum achoreum Blake (8) B, M; 2255–2800m; bs, ds, lf.
* *Polygonum aviculare* L. (39) B, F, L, M, P, S, T; 2225–2895m; bs, dm, ds, lf, rs, sa, wm.
Polygonum douglasii Greene (73) B, D, F, G, M, P, W; 2255–3170m; af, bs, dm, ds, fw, gr, lf, sa, sf, wm, wt; (includes vars. *austinae, douglasii, & microspermum, P. engelmannii*).
Polygonum minimum Wats. (9) B, D, F; 2440–3240m; af, dm, lf, sa, sf, wf, wm.
Polygonum polygaloides Meisn. ssp. *confertiflorum* (Nutt. ex Piper) J.C. Hickman (17) B, D, F, P, W; 2680–3050m; af, dm, ds, gr, lf, sa, sf, wm; (*P. kelloggii* var. *confertiflorum, P. watsonii*).
Polygonum polygaloides Meisn. ssp. *kelloggii* (Greene) J.C. Hickman (17) B, D, F, M, P; 2440–3170m; bs, dm, ds, fw, gr, sa, wm; (*P. kelloggii* var. *kelloggii*).
Polygonum sawatchense Small ssp. *sawatchense* (5) F, G, L, M; 1860–3050m; bs, dm, jw, rs.
* *Rumex acetosella* L. (4) B, F; 2255–2925m; bs, ds, lf, sa, sf.
* *Rumex crispus* L. (11) B, F, G, L; 1725–2860m; dm, ds, fw, rs, sa.
Rumex fueginus Phil. (2) B, F; 2135–2745m; lf, wm; (*R. maritimus* var. *fueginus*).
Rumex occidentalis S. Watson (4) F, G, T; 2255–2470m; bs, wm, wt; (*R. aquaticus* var. *fenestratus*).
Rumex paucifolius Nutt. (104) B, D, F, G, L, M, P, S, T, W; 2160–3795m; af, at, bs, dm, ds, fw, gr, rs, sa, sf, wm, wt.
Rumex triangulivalvis (Danser) Rech. f (30) B, D, F, M, P, S, T, W; 2225–2800m; af, bs, dm, ds, lf, ma, sa, wm, wt; (*R. salicifolus var. triangulivalvis*).
Rumex utahensis Rech. f. (5) B, F, L, P; 1860–2970m; dm, lf, rs, sa, wm.

Portulacaceae (Montiaceae)

Cistanthe rosea (Wats.) Hershkovitz (5) F, S; 2285–2440m; bs.
Cistanthe umbellata (Torr.) Hershkovitz var. *caudicifera* (A. Gray) Kartesz & Gandhi (2) F, M; 2745–3325m; at, wm.
Claytonia lanceolata Pursh (48) B, D, F, L, M, P, S, T, W; 2375–3720m; af, at, bs, dm, ds, fw, gr, lf, wm, wt.
Claytonia megarhiza (A. Gray) Parry ex S. Watson (25) B, D, F, P, T; 2980–4055m; at, dm, gr.
Claytonia multiscapa Rydb. (10) D, P, W; 2880–3500m; dm, gr, sf, wm, wt.
Lewisia pygmaea (A. Gray) B.L. Robins. (88) B, D, F, G, L, M, P, S, T, W; 2345–4025m; af, at, bs, dm, gr, lf, lm, sa, sf, wf, wm, wt.

Lewisia rediviva Pursh var. *rediviva* (25) B, F, L, P, S, T; 1725–2955m; bs, df, dm, ds, jw.

Lewisia triphylla (S. Watson) B.L. Robins. (6) B, F, P; 2440–3170m; af, dm, gr, lf, wf.

Montia chamissoi (Ledeb. ex Spreng.) Greene (8) F, M, W; 2375–2775m; aq, ma, sa, wm.

Potamogetonaceae (Zannichelliaceae)

Potamogeton alpinus Balb (8) B, D, M, P, S; 2375–3175m; aq.

♦ *Potamogeton amplifolius* Tuckerm. (3) F; 2375–2410m; aq.

Potamogeton epihydrus Raf. (2) P; 2520–2745m; aq.

Potamogeton foliosus Raf. (2) G, S; 2375m; aq.

♦ *Potamogeton friesii* Rupr. (1) F; 2680–2715m; aq.

Potamogeton gramineus L. (10) B, F, G, M, P, T; 2410–2895m; aq.

♦ *Potamogeton illinoensis* Morong (1) G; 2440m; aq.

Potamogeton natans L. (1) B; 2865–2925m; aq.

Potamogeton pusillus L. var. *pusillus* (3) B, F, M; 2375–2470m; aq.

Potamogeton pusillus L. var. *tenuissimus* Mert. & W.D.J. Koch (2) G; 2450–2745m; aq.

Potamogeton richardsonii (A. Benn.) Rydb. (7) B, F, G, M; 2315–2745m; aq.

♦ *Potamogeton robbinsii* Oakes (3) B, F, T; 2255–2745m; aq.

♦ *Potamogeton strictifolius* Bennett; (2) F, G; 2440m; aq.

Stuckenia filiformis (Pers.) Börner ssp. *alpina* (Blytt) Hayes, Les, & Král (6) D, F; 2375–3175m; aq.

Zannichellia palustris L. (1) F; 2375m; aq.

Primulaceae

♦ *Androsace chamaejasme* Wulf. var. *carinata* (Torr.) Knuth (13) D, T; 2635–3525m; at, dm, wm; USFS R2 & R4 Sensitive.

Androsace filiformis Retz. (12) B, L, M, P, S; 2210–2925m; fw, sa, wm, wt.

Androsace septentrionalis L. (120) B, D, F, G, L, M, P, S, T, W; 2160–3965m; af, at, bs, df, dm, gr, lf, lw, sf, wm, wt.

Douglasia montana A. Gray (10) B, D, F, G, P, T; 2470–3830m; at, dm, gr.

Primula conjugens (Greene) Mast & Reveal var. *conjugens* (38) B, F, L, M, P, S, T, W; 1790–3525m; af, bs, df, dm, ds, jw, lw, wm; (*Dodecatheon conjugens*).

♦ *Primula egaliksensis* Wormskj. ex Hornem. (2) G; 2440m; ma.

Primula parryi A. Gray (51) B, D, F, G, P, T; 2620–4025m; at, dm, fw, gr, wm.

Primula pauciflora (Greene) Mast & Reveal var. *pauciflora* (71) B, D, F, G, L, M, P, S, T, W; 2285–4025m; af, at, bs, dm, fw, gr, lf, ma, wm, wt; (*Dodecatheon pulchellum*).

Ranunculaceae

Aconitum columbianum Nutt. ssp. *columbianum* (1) M; 2440–2500m; dm.

Actaea rubra (Aiton) Willd. (36) B, F, G, L, M, P, T, W; 1860–3170m; af, df, fw, gr, lf, rs, sf, wm, wt.

Anemone lithophila Rydb. (4) G; 3230–3535m; at.

Anemone multifida Poir. var. *multifida* (41) F, G, L, M, T, W; 2285–3180m; bd, bs, dm, fw, gr, lf, lm, lw, ma, sf, wm, wt.

Anemone parviflora Michx. (4) F, G; 2375–3415m; sa, wm.

Anemone patens L. var. *multifida* Pritz. (28) D, F, G, L, P, T; 2280–4110m; at, bs, dm, gr, wm, wt.

Anemone tetonensis Porter ex Britt. (9) G, T, W; 2620–3415m; at, dm, lm.

Aquilegia coerulea E. James var. *coerulea* (87) B, D, F, G, L, M, P, T, W; 2325–3840m; af, at, bs, dm, fw, gr, lf, lm, sa, sf, wf, wm, wt.

Aquilegia flavescens Wats. (17) D, L, P, W; 2575–3830m; at, dm, fw, gr.

Aquilegia jonesii Parry (9) L, T; 2490–3525m; at, dm, lm.

Caltha leptosepala DC. (72) B, D, F, M, P, W; 2555–3840m; at, dm, fw, lf, ma, sa, wm, wt.

Clematis hirsutissima Pursh var. *hirsutissima* (13) F, L, S, T; 2210–2905m; af, bs, dm, ds, lf.

Clematis ligusticifolia Nutt. (2) L; 1725–1910m; bs, rs.

Clematis occidentalis (Hornem.) DC. var. *grosseserrata* (Rydb.) J.S. Pringle (5) B, G; 2255–2745m; af, df, sf, wm.

Delphinium bicolor Nutt. (43) B, F, L, M, P, S; 2285–3170m; af, bs, dm, ds, fw, lf, lw.

Delphinium geyeri Greene (5) F, L; 1765–2375m; bs, jw.

Delphinium glaucum S. Watson (27) B, F, G, L, M, T, W; 2330–3155m; bs, dm, sf, wm, wt; (includes *D. occidentale*).

Delphinium nuttallianum Pritz. ex Walpers (42) D, F, L, P, S, T, W; 1850–2905m; af, bs, dm, gr, jw, wm.

Myosurus apetalus Gay var. *borealis* Whittem. (2) F, P; 2725–2940m; dm, wm.

Myosurus apetalus Gay var. *montanus* (Campbell) Whittem. (3) B, S; 2410–2745m; aq, bs, wm.

Myosurus minimus L. (2) F, G, M; 2440–2530m; af, bs.

Ranunculus acriformis A. Gray var. *montanensis* (Rydb.) Benson (12) D, F, M, T, W; 2375–2905m; af, bs, lf, ma, wm, wt.

Ranunculus adoneus A. Gray (8) B, D, F, G, T, W; 2635–3720m; at, dm.

Ranunculus alismifolius Geyer ex Benth. var. *hartwegii* (Greene) Jeps. (15) B, F, P, T, W; 2560–3230m; af, bs, lf, lm, ma, wm, wt.

Ranunculus alismifolius Geyer ex Benth. var. *montanus* S. Watson (18) B, F, M, P, W; 2375–3170m; af, bs, ds, fw, wm, wt.

Ranunculus aquatilis L. var. *diffusus* With. (17) B, D, F, G, M, P, T; 2225–3345m; aq; (includes *R. circinatus*).

Ranunculus cymbalaria Pursh (18) D, F, L, M, P, S, T, W; 1725–3120m; af, aq, ma, wm, wt; (includes vars. *cymbalaria* & *saximontanus*).

Ranunculus eschscholtzii Schltdl. var. *eschscholtzii* (65) B, D, F, L, M, P; 2520–3840m; at, dm, fw, gr, lf, ma, sf, wm, wt.

Ranunculus eschscholtzii Schltdl. var. *eximius* (Greene) Benson (3) D, P; 3090–3790m; at, wm.

Ranunculus eschscholtzii Schltdl. var. *trisectus* (Eastw.) Benson (11) F, G, M, T; 2435–3535m; at, dm, fw, gr, lm, wm.

Ranunculus flammula L. var. *reptans* (L.) E. Mey. (28) B, D, F, G, P; 2225–3160m; aq, ma, sa, wm, wt.

Ranunculus glaberrimus Hook. var. *ellipticus* (Greene) Greene (58) B, F, G, L, M, P, S, W; 2150–3655m; af, at, bs, df, dm, gr, wm, wt.

Ranunculus gmelinii DC. (5) F, G, M, W; 2470–2800m; aq, wm.

Ranunculus hyperboreus Rottb. (4) B, F, M; 2285–2560m; aq, ma, wt; (*R. natans*).

Ranunculus inamoenus Greene var. *inamoenus* (30) D, F, G, M, W; 2375–3505m; af, at, bs, dm, ds, fw, wm, wt; (includes var. *alpeophilus*).

Ranunculus jovis A. Nels. (3) B, F; 2375–2955m; bs, dm, wm.

Ranunculus macounii Britton (10) B, F, G, L, W; 2210–2500m; af, df, sa, wm.

Ranunculus pedatifidus Sm. var. *affinis* (R. Br.) L.D. Benson (2) T; 2665–3525m; dm.

Ranunculus pygmaeus Wahlenb. (9) B, D, F, G, P, W; 2865–4025m; at, dm, gr, wm.

* *Ranunculus repens* L. var. *repens* (1) F; 2375m; wm.

Ranunculus sceleratus L. var. *multifidus* Nutt. (5) F, G; 2315–2500m; ma, wm.

* *Ranunculus testiculatus* Crantz (5) B, L; 1725–2330m; ds; (*Ceratocephala testiculata*).

Ranunculus uncinatus D. Don (15) B, F, M, P, W; 2375–2900m; dm, fw, sf, wm, wt.

Thalictrum alpinum L. (11) F, G, P, T; 2440–3185m; ma, wm, wt.

Thalictrum fendleri Engelm. ex A. Gray (13) F, G, L, M; 1860–3110m; af, dm, fw, rs, sff, wm, wt.

Thalictrum occidentale A. Gray (13) B, F, G, L, M; 2160–3050m; af, dm, lf, sf, wm, wt.

Thalictrum sparsiflorum Turcz. ex Fisch. & C.A. Mey. (37) B, D, F, G, P, S, T, W; 2175–3285m; af, fw, lm, ma, sa, wm, wt.

Thalictrum venulosum Trel. (2) B, F; 2375m; sa, wt.

Trollius albiflorus (A. Gray) Rydb. (69) B, D, F, L, M, P, T, W; 2440–3520m; af, at, dm, fw, gr, lf, ma, sf, wm, wt; (*T. laxus* var. *albiflorus*).

Rhamnaceae

Ceanothus velutinus Douglas ex Hook. var. *velutinus* (26) B, F, L, P, S, W; 2175–3170m; af, bs, df, dm, ds, gr, lf, sf.

Rosaceae

Amelanchier alnifolia (Nutt.) Nutt. ex M. Roem. var. *alnifolia* (21) B, F, L, P; 2160–2745m; af, bs, df, dm, gr, jw, lf, sa.

Amelanchier alnifolia (Nutt.) Nutt. ex M. Roem. var. *pumila* (Torr. & A. Gray) A. Nelson (17) B, D, F, L, M, P, S, W; 2260–3160m; bs, dm, ds, fw, lf.

Amelanchier utahensis Koehne (8) B, F, L; 1850–3110m; af, bs, dm.

Chamaerhodos erecta (L.) Bunge var. *parviflora* (Nutt.) C.L. Hitchc. (4) S, T; 2450–2765m; bs, dm, gr.

Crataegus rivularis Nutt. (2) L; 2065–2175m; dm, wt.

Dasiphora fruticosa (L.) Rydb. (125) B, D, F, G, L, M, P, S, T, W; 2175–3795m; af, at, bd, bs, dm, fw, gr, lf, lm, lw, ma, rs, sa, sf, wf, wm, wt; (*Pentaphylloides floribunda, Potentilla fruticosa*).

Dryas octopetala L. var. *hookeriana* (Juz.) Breit. (20) D, G, P, T; 2665–4025m; at, dm, gr, lm.

Drymocallis arguta (Pursh) Rydb. (32) B, D, F, M, P, S, T; 2255–3420m; af, bs, df, dm, fw, gr, lf, sf; (*Potentilla arguta*).

Drymocallis pseudorupestris (Rydb.) Rydb. (70) B, D, F, G, L, M, P, T, W; 1850–3565m; af, at, bs, dm, ds, fw, gr, lf, lm, wf, wm; (*Potentilla glandulosa* var. *pseudorupestris*).

Fragaria vesca L. (39) B, D, F, G, L, P, S, T, W; 2280–3500m; af, bs, df, dm, fw, lf, sf, wm, wt.

Fragaria virginiana Mill. (70) B, D, F, G, L, M, P, S, T, W; 2210–3170m; af, bs, df, dm, ds, fw, lf, sf, wm, wt.

Geum aleppicum Jacq. (3) P, W; 2530–3295m; at, ds.

Geum macrophyllum Willd. var. *perincisum* (Rydb.) Raup (66) B, D, F, G, L, M, P, S, T, W; 1860–3180m; af, dm, fw, ma, rs, sa, wm, wt.

Geum rossii (R. Br.) Ser. var. *turbinatum* (Rydb.) C.L. Hitchc. (59) B, D, F, G, M, P, T, W; 2665–3965m; at, dm, gr, lm, wm.

Geum triflorum Pursh var. *ciliatum* (Pursh) Fassett (95) B, D, F, G, L, M, P, S, T, W; 1790–3415m; af, at, bs, df, dm, ds, gr, jw, lm, rs, wm, wt.

Geum triflorum Pursh var. *triflorum* (7) L, M, S, T, W; 2280–3160m; af, bs, wt.

Holodiscus dumosus (Nutt. ex Hook.) Heller (13) L, P; 1850–2885m; bs, dm, jw, lm.

Ivesia gordonii (Hook.) T. & G. (28) B, F, P, S; 2345–3795m; at, bd, dm, gr, sa, wf, wm.

Petrophyton caespitosum (Nutt.) Rydb. (7) G, L; 1850–2745m; lm.

Potentilla anserina L. (13) B, F, S; 2225–2500m; af, ds, ma, sa, sf, wm, wt.

Potentilla biennis Greene (2) B, S; 2285–2375m; gr, wm.

Potentilla bipinnatifida Douglas ex Hook. var. *bipinnatifida* (2) G, T; 2895–3230m; dm, lm.

Potentilla concinna Richardson var. *concinna* (28) B, F, G, L, M, P, S, W; 2160–3355m; af, bs, dm, gr, lm, wt.

Potentilla diversifolia Lehm. var. *diversifolia* (179) B, D, F, G, L, M, P, S, T, W; 2210–3965m; af, at, bs, dm, fw, gr, lf, lm, ma, rs, sf, wm, wt.

Potentilla diversifolia Lehm. var. *perdissecta* (Rydb.) C.L. Hitchc. (21) B, D, G, L, T; 2460–3535m; at, bs, dm, fw, lm.

Potentilla gracilis Douglas ex Hook. var. *brunnescens* (Rydb.) C.L. Hitchc. (38) B, F, G, L, M, S, W; 2260–3050m; af, bs, df, dm, fw, gr, lf, lm, sa, sf, wf, wm, wt.

Potentilla gracilis Douglas ex Hook. var. *elmeri* (Rydb.) Jeps. (11) F, G, L, M, S; 2330–2745m; bs, dm, ds, wm.

Potentilla gracilis Douglas ex Hook. var. *fastigiata* (Nutt.) S. Watson (37) B, F, G, L, S, T, W; 2255–3110m; af, bs, df, dm, fw, lf, ma, rs, sf, wm, wt; (var. *nuttallii*).

Potentilla gracilis Douglas ex Hook. var. *flabelliformis* (Lehm.) Nutt. ex T. & G. (1) T; 2255m; dm.

Potentilla gracilis Douglas ex Hook. var. *pulcherrima* (Lehm.) Fernald (68) B, D, F, G, L, M, P, T, W; 2160–3230m; af, bd, bs, df, dm, ds, gr, lm, lw, sa, sf, wf, wm.

Potentilla hippiana Lehm. var. *effusa* (Douglas ex Lehm.) Dorn (22) B, D, L, P, S, T; 2005–3525m; bs, df, dm, ds, gr, lm.

Potentilla hookeriana Lehm. var. *hookeriana* (1) G; 3050m; dm.

♦ *Potentilla hyparctica* Malte (10) D, F, G; 3170–4110m; at, dm, gr.

Potentilla nivea L. (6) D, F, P, T; 3110–3505; at, dm, gr.

* *Potentilla norvegica* L. ssp. *monspeliensis* (L.) Asch. & Graebn. (13) B, F, S; 2255–2895m; bs, df, dm, ds, lf, sa, wm.

Potentilla ovina Macoun var. *decurrens* (S. Watson) S.L. Welsh & B.C. Johnst. (7) B, D, P; 2630–3700m; at, dm, wm.

Potentilla ovina Macoun var. *ovina* (53) D, F, G, L, P, S, T, W; 2210–3600m; at, bs, df, dm, fw, gr, lm.

Potentilla pensylvanica L. (10) L, T; 2255–3180m; bs, dm, jw, wm.

Potentilla plattensis Nutt. (6) F, L, S; 2360–2510m; bs, dm, lw, wm.

Potentilla rubricaulis Lehm. (11) D, G, L, T; 2065–4110m; at, bs, dm, lm.

Prunus virginiana L. var. *melanocarpa* (A. Nelson) Sarg. (35) B, F, L, P; 1725–2885m; af, bs, df, ds, fw, gr, jw, lf, lm, rs, wt.

Purshia tridentata (Pursh) DC. (59) B, F, L, M, P, S; 1725–2885m; af, bs, df, ds, gr, jw, lw.

Rosa nutkana C. Presl var. *hispida* Fernald (1) T; 2620m; gr.

Rosa sayi Schwein (34) B, D, F, G, L, M, S, T; 1725–3120m; af, bd, bs, ds, fw, gr, jw, lm, lw, sa, sf, wm, wt.

Rosa woodsii Lindl. (25) B, F, L, M, P, T, W; 1850–3050m; af, bs, dm, ds, lf, lm, rs, wt.

Rubus idaeus L. var. *aculeatissimus* Regel & Tiling (65) B, D, F, G, L, M, P, S, T, W; 1850–3720m; af, at, bs, df, dm, fw, gr, lf, lm, sf, wm; (var. *strigosus*).

Rubus idaeus L. var. *peramoenus* (Greene) Fern. (3) L, T; 2550–3180m; dm.

Rubus parviflorus Nutt. var. *parviflorus* (7) B, F, W; 2255–2800m; af, fw, wt.

* *Sanguisorba minor* Scop. ssp. *muricata* Briq. (1) T; 2225m; ds.

Sibbaldia procumbens L. (79) B, D, F, G, M, P, W; 2785–4110m; at, dm, fw, gr, lf, lm, ma, sf, wm, wt.

Sorbus scopulina Greene (3) B, F, L; 2255–2800m; af, df, lf, sf.

Spiraea betulifolia Pall. var. *lucida* (Douglas ex Hook.) C.L. Hitchc. (1) F; 2500m; lf.

Rubiaceae

Galium aparine L. (3) L; 1725–2475m; bs, dm, jw.

Galium bifolium S. Watson (19) B, F, L, M, P; 2345–3295m; af, bs, dm, fw, gr, lf, lm.

Galium boreale L. (52) B, F, G, L, M, P, S, T, W; 1860–3170m; af, bd, bs, df, dm, ds, fw, lf, lm, rs, sa, sf, wm.

Galium trifidum L. var. *subbiflorum* Wiegand (10) D, L, P, S, W; 2210–3205m; fw, ma, wm, wt.

Galium trifidum L. var. *trifidum* (34) B, F, G, M, P, S; 2285–3080m; fw, ma, rs, sa, wm, wt.

Galium triflorum Michx. (4) B, F, G; 2255–2680m; fw, lf, sf.

♦ *Kelloggia galioides* Torr. (1) L; 2700m; af.

Rupiaceae

Ruppia cirrhosa (Petagna) Grande (1) F; 2305m; aq.

Salicaceae

Populus acuminata Rydb. (1) L; 1860–1980m; sa.

Populus angustifolia E. James (26) B, D, F, L, M, T; 1725–3120m; af, bs, fw, lf, rs, sa, wm, wt.

Populus balsamifera L. var. *balsamifera* (10) D, F, G, P, T, W; 2175–3120m; af, bs, ds, gr, wm.

Populus tremuloides Michx. (88) B, D, F, L, M, P, S, T, W; 1850–3295m; af, bs, df, dm, ds, fw, gr, lf, lm, lw, rs, sa, wm.

Salix arctica Pall. var. *petraea* (Andersson) Bebb (62) B, D, F, G, M, P, T, W; 2665–4110m; at, dm, gr, lm, wm.

Salix bebbiana Sarg. var. *bebbiana* (31) B, F, L, P, S, T; 2065–2745m; af, fw, ma, rs, sa, wm, wt.

Salix boothii Dorn (64) B, D, F, G, L, M, P, S, T, W; 2210–3205m; af, dm, fw, wm, wt.

Salix brachycarpa Nutt. var. *brachycarpa* (22) D, F, G, M, P, T, W; 2375–3525m; fw, sa, wm, wt.

♦ *Salix candida* Flueggé ex Willd. (3) F, P; 2375–2490m; ma, wt; USFS R2 Sensitive.

Salix drummondiana Barratt ex Hook. (20) B, D, F, G, M, P, T, W; 2375–3525m; dm, fw, lf, wm, wt.

Salix eastwoodiae Ckll. ex Heller (20) B, D, F, G, M, P, T, W; 2665–3500m; fw, lm, wm, wt.

Salix eriocephala Michx. var. *watsonii* (Bebb) Dorn (7) B, F, L, W; 1860–2565m; rs, wt.

Salix exigua Nutt. (8) F, L, T; 1790–2670m; rs, sa, wm, wt.

Salix farriae Ball (5) W; 2560–2745m; wm, wt.

Salix geyeriana Andersson var. *geyeriana* (64) B, D, F, G, L, M, P, S, T, W; 2210–3120m; af, dm, fw, gr, sa, sf, wm, wt.

Salix glauca L. var. *villosa* Andersson (81) B, D, F, G, P, T, W; 2635–3830m; at, dm, gr, lm, ma, sa, wm, wt.

Salix lasiandra Benth. var. *caudata* (Nutt.) Sudw. (12) B, D, L, P, S; 2210–2625m; af, fw, sa, wm, wt.

Salix lemmonii Bebb (8) P, S, W; 2410–3060m; fw, wt.

Salix melanopsis Nutt. (3) F, L, M; 2065–2315m; sa. wm.

Salix planifolia Pursh (84) B, D, F, G, L, M, P, T, W; 2375–3840m; at, dm, fw, gr, ma, wm, wt; (includes vars. *monica* & *planifolia*).

Salix reticulata L. var. *nana* Andersson (40) B, D, G, P, T; 2665–3830m; at, dm, gr, lm, wm, wt.

Salix rotundifolia Trautv. var. *dodgeana* (Rydb.) E. Murray (13) D, G, P, T; 3155–4110m; at, lm, wm.

Salix scouleriana Barratt ex Hook. (11) B, F, T; 2255–3050m; af, bs, df, lf, sa, wm.

Salix tweedyi (Bebb ex Rose) Ball (24) B, D, F, L, P, W; 2605–3525m; af, fw, gr, wm, wt.

Salix wolfii Bebb var. *idahoensis* Ball (5) D, M, W; 2500–3185m; wt.

Salix wolfii Bebb var. *wolfii* (42) D, F, G, M, P, T, W; 2290–3365m; fw, wm, wt.

Santalaceae (Viscaceae)

Arceuthobium americanum Nutt. ex Engelm. (21) B, F, G, M, P, W; 2315–2835m; af, df, dm, lf.

Arceuthobium cyanocarpum (A. Nelson ex Rydb.) A. Nelson (2) B, P; 2560–2745m; lw.

Comandra umbellata (L.) Nutt. var. *pallida* (A. DC.) M.E. Jones (34) B, F, L, M, P, S, T, W; 1725–3525m; bs, df, dm, gr, jw, lw.

Sapindaceae (Aceraceae)

acer glabrum Torr. var. *glabrum* (25) B, F, G, L, P, T; 1850–3320m; af, bs, df, dm, ds, fw, gr, lm, lw, rs, wf.

Saxifragaceae

Boykinia heucheriformis (Rydb.) Rosend. (23) D, F, G, L, T; 2865–3600m; at, dm, gr, lm; (*Telesonix heucheriformis*).

Heuchera parvifolia Nutt. ex Torr. & A. Gray (59) B, D, F, G, L, M, S, T, W; 1725–3350m; af, at, bd, bs, dm, fw, gr, jw, lf, lm, lw, sf.

Lithophragma glabrum Nutt. var. *ramulosum* (Suksd.) B. Boivin (67) B, D, F, G, L, M, P, S, T, W; 1850–3735m; af, at, bs, dm, ds, fw, gr, lf, ma, sf, wm, wt.

Lithophragma parviflorum (Hook.) Nutt. ex Torr. & A. Gray (8) B, F, S; 2315–2865m; af, bs, gr, lf.

Lithophragma tenellum Nutt. (33) B, F, L, M, P, S; 2150–3170m; af, bs, df, dm, rs, wm.

Mitella pentandra Hook. (54) B, D, F, G, L, M, P, T, W; 2470–3500m; fw, lf, ma, wm, wt.

Mitella stauropetala Piper var. *stenopetala* (Piper) Rosend. (6) F, G; 2530–3050m; df, dm, fw, lf, sf.

Saxifraga adscendens L. var. *oregonensis* (Raf.) Breit. (10) B, D, F, G; 3230–3965m; at, gr.

Saxifraga cernua L. (11) D, F, G, P, T; 2800–3965m; at, dm, gr.

Saxifraga cespitosa L. var. *minima* Blank. (10) D, F, G; 3230–3965m; at, gr.

♦ *Saxifraga chrysantha* A. Gray (8) D, F, P; 3155–4025m; at, gr; (*S. serpyllifolia* var. *chrysantha*).

Saxifraga flagellaris Willd. ex Sternb. var. *crandallii* (Gand.) Dorn (13) B, D, G, P, T; 2980–4110m; at, dm, gr, wm.

Saxifraga occidentalis Wats. (18) B, D, F, G, M, P, T; 2440–3840m; at, dm, gr, lf, sf, wm.

Saxifraga odontoloma Piper (75) B, D, F, G, L, M, P, T, W; 2335–3790m; at, fw, lf, lm, ma, sa, sf, wm, wt.

Saxifraga oppositifolia L. ssp. *oppositifolia* (11) D, G, T; 2665–3700m; at, dm, lm.

Saxifraga rhomboidea Greene (90) B, D, F, G, L, M, P, S, T, W; 2255–4025m; at, bd, bs, dm, gr, lm, rs, wf, wm, wt.

Saxifraga rivularis L. var. *debilis* (Engelm. ex A. Gray) Dorn (16) B, D, F, G, P, T, W; 2375–3790m; at, dm, fw, gr, lm, sf.

Saxifraga rivularis L. var. *flexuosa* (Sternb.) Engl. & Irmsch. (33) B, D, F, G, P, T, W; 2620–3965m; at, gr, lm, wm.

Saxifraga subapetala E. Nelson (24) D, F, M, T, W; 2375–3625m; at, bs, fw, gr, wm, wt.

Scrophulariaceae

* *Verbascum thapsus* L. (1) B; 2255–2315m; bs.

Solanaceae

* *Hyoscyamus niger* L. (2) F, S; 2315–2375m; bs, ds.

Nicotiana attenuata Torr. ex Wats. (2) F, S; 2285–2315m; bs.

Solanum triflorum Nutt. (2) T; 2255–2285m; bs, ds.

Tamaricaceae

*● *Tamarix chinensis* Lour. (1) F; 2375–2410m; sa.

Typhaceae (Sparganiaceae)

Sparganium angustifolium Michx. (18) B, D, F, G, W; 2315–3460m; aq.

Sparganium emersum Rehmann (6) B, F, S; 2285–2715m; aq, wt.

Sparganium natans L. (2) P; 2745m; aq.

Typha latifolia L. (2) B, F; 2345–2620m; aq, sa.

Urticaceae

Urtica dioica L. var. *occidentalis* Wats. (1) L; 2335–2430m; ds.

Urtica dioica L. var. *procera* (Muhl. ex Willd.) Wedd. (4) F, G, L; 1860–2745m; bs, rs, wm.

Verbenaceae

Verbena bracteata Lag. & Rodr. (1) F; 2255–2285m; ds.

Violaceae

Viola adunca Sm. (77) B, D, F, G, L, M, P, S, T, W; 2160–3795m; af, at, bs, dm, ds, fw, gr, lf, ma, rs, sf, wm, wt.

Viola palustris L. (25) B, D, F, G, L, P, W; 2385–3205m; dm, fw, ma, wm, wt.

Viola praemorsa Douglas ex Lindl. (44) B, F, L, M, P, S, W; 1850–3415m; af, at, bs, dm, ds, lw.

Viola purpurea Kellogg var. *venosa* (Wats.) Brainerd (24) B, F, L, P, S; 2375–3415m; af, at, bs, dm, ds, gr, lf, lm, sf.

Viola sororia Willd. var. *affinis* (Leconte) L.E. McKinney (6) D, F, L; 2065–3120m; af, fw, wm, wt; (*V. nephrophylla*).

Viola vallicola A. Nelson (22) B, F, L, P, S; 1850–2900m; bs, dm, gr, lm.

ADDENDUM

In the summer of 2013, two new species in the Poaceae were documented for the South Pass subregion of the Wind River Range: *Bouteloua gracilis* (H.B.K.) Lag. ex Griffiths (*Heidel 3874*, RM) and *Muhlenbergia cuspidata* (Torr. ex Hook.) Rydb. (*Heidel 3876*, RM).

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ANNOUNCEMENTS

2013 Delzie Demaree Travel Award Recipients

The 25th Annual Delzie Demaree Travel Award was presented at the 50th Annual Systematics Symposium (11–12 Oct 2013) at the Missouri Botanical Garden, St. Louis. Six students were presented the Travel Award: **Dakota Ahrendsen,** University of Nebraska, Omaha; **Shelly Aust,** University of Nebraska, Omaha; **Benjamin Gahagen,** Ohio University; **Alison Scott,** University of Wisconsin, Madison; **Harlan Svoboda,** Ohio University; **Eduardo Tomaz,** Ohio University.

The 2013 Travel Awards were underwritten by **1)** Contributors to the Delzie Demaree Travel Award Endowment, **2)** Members of the Delzie Demaree Travel Award Committee, **3)** Mary Isabelle Eggers, Williamsburg, Virginia, and **4)** John Clayton Chapter of the Virginia Native Plant Society.

Anyone interested in making a contribution to Delzie Demaree Endowment Fund, which supports the travel award, may make contributions by VISA or MasterCard or by a check, payable to Botanical Research Institute of Texas, to Barney Lipscomb, 1700 University Drive, Fort Worth, TX 76107-3400, U.S.A. 1-817-332-7432; Email: barney@brit.org. Thank you.

The 2014 Applications for the Delzie Demaree Travel Award

Applications for the 2014 Delzie Demaree Travel Award should include a letter from the applicant telling how symposium attendance will benefit his/her graduate work and letter of recommendation sent by the major professor. Please send letters of application to: Dr. Donna M.E. Ware, P.O. Box 8795, Herbarium, Biology Department, The College of William and Mary, Williamsburg, Virginia 23185-8795, U.S.A. 1-757-221-2799; Email: ddmware@wm.edu. Applications may be sent to: Barney Lipscomb, 1700 University Drive, Fort Worth, Texas 76107-3400, U.S.A. 1-817-332-7432; Email: barney@brit.org. The period for receiving applications will end three weeks prior to the date of the symposium if a sufficient number of applications are in hand at that time. Anyone wishing to apply after that date should inquire whether applications are still being accepted before applying. The Systematics Symposium dates for 2014 are 10–11 October 2014 (dates tentative and subject to change).

The Delzie Demaree Travel Award was established in 1988 honoring **Delzie Demaree** who attended 35 out of a possible 36 symposia before he died in 1987. Delzie Demaree was a frontier botanist, explorer, discoverer, and teacher. His teaching career as a botanist began in Arkansas at Hendrix College in 1922. He also taught botany at the University of Arkansas, Navajo Indian School, Yale School of Forestry, Arkansas A&M, and Arkansas State University at Jonesboro where he retired as professor emeritus in 1953. One of the things he enjoyed most as a botanist was assisting students with their field botany research.

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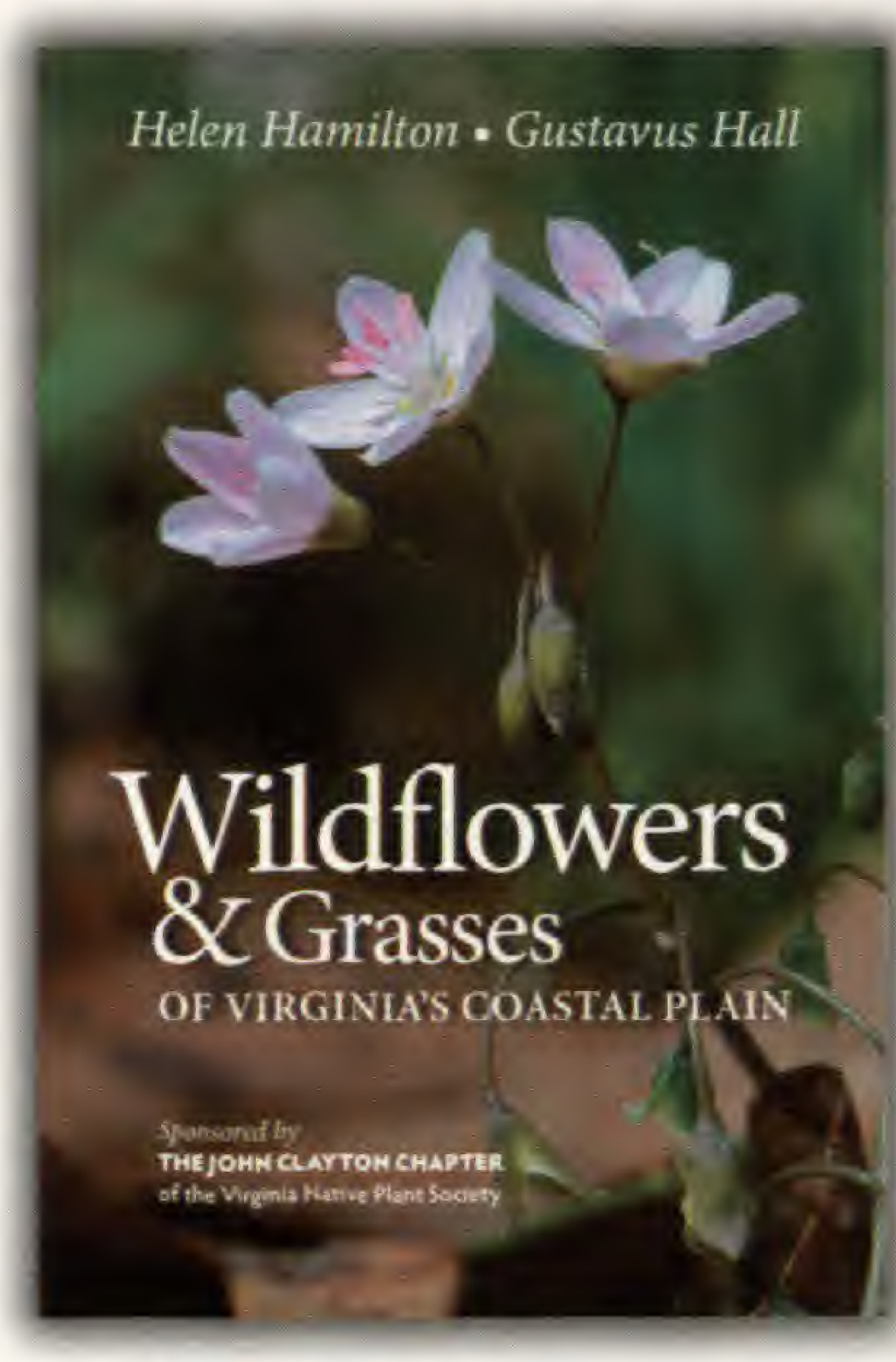

Wildflowers & Grasses of Virginia's Coastal Plain

August 2013

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The journal is published twice yearly in a multiple topic format and provides information to scientists, professionals, and the general public for research, education, and cultural enhancement. All articles are indexed and abstracted in print and/or electronic form by the following: AGRICOLA Database (National Agricultural Library); Applied Botany Abstracts; Biosciences Information Service of Biological Sciences (BIOSIS); Current Awareness in Biological Sciences (CABS); ISI Thomson; The Kew Record of Taxonomic Literature; Natural Products Alert (NAPRALERT); Scopus® database, SCImago Journal and Country Rank (Elsevier B.V.); and Referativnyi Zhurnal (Abstracts Journal of the Institute of Scientific Information of the Republic of Russia).

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